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VOLUME 61 [W. B. No. 1106] NUMBER 6

MONTHLY WEATHER REVIEW

JUNE 1933

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UNITED STATES DEPARTMENT OF AGRICULTURE

WEATHER BUREAU

WASHINGTON, D.C.

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CORRECTION

Volume 59, May 1931, page 191: Table 2, heading for second part of the table, "miles per second" should be "meters per second"

MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

VOL. 61, No. 6
W. B. No. 1106

JUNE 1933

CLOSED AUGUST 3, 1933
ISSUED SEPTEMBER 22, 1933

FLOODS OF MARCH TO JUNE 1933 IN THE UNITED STATES

By RICHMOND T. ZOCH

[Weather Bureau, Washington, July 1933]

Each spring and early summer some of the rivers of the United States overflow their banks. In some years these overflows are infrequent and relatively unimportant, while in others they are frequent and attract considerable attention. The year of 1933 has been of the latter type.

Interest in floods has increased in recent years because of many extensive flood-protection projects. This article points out the most significant features of the floods of March, April, May, and June of 1933.

ST. LAWRENCE DRAINAGE

Minor floods occurred in the rivers of Michigan in March, April, and May, moderate floods in the Sandusky River in March, and in the Maumee River in May.

ATLANTIC SLOPE DRAINAGE

There were minor floods in the rivers of the South Atlantic Slope in all 4 months, and in the rivers of the Middle Atlantic Slope in April. Moderate floods occurred in the Connecticut River and in the James River in April.

EAST GULF OF MEXICO DRAINAGE

There were minor floods in nearly all of the rivers of this section in March and April. In April there also was a moderate flood in the Pearl River, and in May a moderate flood in both the West Pearl and Bogue Chitto Rivers.

MISSISSIPPI SYSTEM

Upper Mississippi Basin

Heavy rains in the upper Mississippi Basin which began on March 28, became unusually heavy on March 31 and April 1, and, in some sections, continued until the middle of May, caused floods in many of the tributaries of the Mississippi River. They caused two crests in the Illinois River and three in the Mississippi.

In southern Wisconsin and northern Iowa deep snows were melting somewhat rapidly when these rains began, and the combined rain and melting snow caused some very rapid rises, especially in the small streams.

The first crest in the Illinois River was the highest flood in the upper part since 1927 and the highest in the lower part since 1929. Before the river had fallen below the flood stage at all points a second and greater rise began. The crest of this second rise was only moderately high at Morris, lower in fact than the earlier crest. At Peru the crest was equal to the highest gage reading of record, but was 3.2 feet lower than the high watermark of June 1916. At Henry it was the highest of record. At Peoria it was the highest actual gage reading of record, but was 0.87 foot lower than the high watermark of June 1844. At Havana and Beardstown the crests were the second highest, being exceeded only by the crests of October 1926. At Pearl the crest was not so high as on several other occasions, probably owing to comparatively low water in the Mississippi at the mouth of the Illinois, and to breaks in levees above Pearl.

Although the stages were extremely high in the Illinois River, flood losses were not so large as might have been expected. The river rose so slowly that movable property could be taken care of. At Beardstown flood protection works have been built to protect the city from floods up to 27.75 feet on the gage.

The three crests in the Mississippi River were not of much significance.

Missouri Basin

Only three minor floods occurred in the Missouri Basin during these 4 months. The fact that the Missouri River was comparatively low lessened the severeness of the floods in the lower Mississippi.

Ohio Basin

In no southern tributary of the Ohio, except the Monongahela, was there more than a minor flood from March to June. However, nearly all of these tributaries were close to bankful stages for considerable periods.

Important floods occurred in every northern tributary of the Ohio River in March. Except for the Wabash System, only minor floods occurred in these tributaries in April and May.

In the Wabash System stages were comparatively low at the beginning of March. Heavy rainfall began in parts of this basin on March 9, and from then until April 19 was repeated at rather frequent intervals. The soil became saturated, and the run-off thereafter was comparatively high, although the rate of run-off seemingly varied considerably owing to irrgular distribution of rainfall. River stages at all stations were somewhat low at the beginning of May due to the comparatively dry weather of the last 10 days of April. In May, however, rains occurred frequently with occasional to numerous, but rather irregularly distributed, excessive falls.

The five greatest general floods of recent years in the Wabash-White Valley were those of March 1913, February 1916, April 1922, January 1930, and May 1933. As a rule that of May 1933 stands fourth in order of severity in the White River Valley, although at Anderson, Ind., it was second, and at Noblesville, Ind., third. In the Wabash River Valley, however, there was more variation. At Bluffton, Ind., it was fifth; at La Fayette, Ind., fourth; at Terre Haute, Ind., second; at Mount Carmel,

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Ill., fourth; while at Logansport, Ind., the flood stage was not reached.

This irregularity in order was no doubt owing to the very irregular distribution of the rainfall, both as to amount and time. However, this irregularity is not hard to account for since the May 1933 flood occurred later in the year than any of the other floods mentioned above.

In the Ohio River three crests occurred. The first extended from Pittsburgh, Pa., to Cairo, Ill., from March 15 to April 4. The second from Dam No. 47 to Cairo, from April 22 to April 24. The third from Portsmouth, Ohio, to Cairo, Ill., from May 14 to May 24. The second of these crests was the least important and the rise it caused was not even noticed in the lower Mississippi River below New Madrid, Mo.

The flood of March was more severe than any since the very disasterous one of 1913. Table 1 shows how this flood compares with others since 1913 for the Ohio River. In it are given, for a few selected points, all the crest stages from 1913 to 1933 that were higher than the crest stages of the March 1933 flood.

TABLE 1.—*Stages higher than March 1933 since 1913*

Station	Crests	Year	Remarks
Pittsburgh, Pa.	31.6	1915	
	30.3	1918	
	32.4	1924	
	29.7	January 1927	
	30.4	December 1927	
St. Marys, W.Va.	39.7	1915	
	41.7	January 1927	
Marietta, Ohio	44.0	1927	
Parkersburg, W.Va.	45.5	1927	
Point Pleasant, W.Va.			Highest since 1913.
Cincinnati, Ohio			Do.
Louisville, Ky.			Do.
Evansville, Ind.			Do.
Shawneetown, Ill.			Do.
Paducah, Ky.	48.9	1922	

The significant feature of this flood was the suddenness with which it took place. On March 12, 1933, fair weather prevailed over the Ohio Valley, and while a low was centered over Alberta, no especially heavy rains were indicated for the Ohio Valley. The river was at about average stage for this season of the year. Table 2 shows the stages of the river at selected points at 8 a.m. on March 13, 1933.

TABLE 2.—*River stages at large cities on Ohio River on Mar. 13, 1933*

Station	Stage	Remarks
Pittsburgh, Pa.	12.8	
Parkersburg, W.Va.	12.4	
Huntington, W.Va.	17.3	
Portsmouth, Ohio	20.3	
Cincinnati, Ohio	22.3	
Louisville, Ky.:		
Upper gage	17.0	Pool stage.
Low-water gage	16.8	Do.
Owensboro, Ky.	13.9	Lowest for month.
Evansville, Ind.	16.2	Do.
Paducah, Ky.	18.6	
Cairo, Ill.	26.2	

Not only was the river at practically an average stage, but also the ground was not overly moist for this season. Precipitation was above normal over all of the Ohio Valley, except the extreme eastern part, in December 1932. In January 1933 precipitation was below normal for all of the Ohio Valley except eastern Kentucky. For February 1933 precipitation was below normal over all of the Ohio Valley except the Cumberland and Tennessee Basins. For the entire winter (December–February) precipitation was below normal in the mountainous eastern section and about normal in the remainder of the basin. There was no snow on the ground when rain began on the night of March 12–13.

The low which was centered over Alberta on the morning of March 12 had moved to western Iowa on the morning of March 13, and had caused rains to set in over the Ohio Valley during the night of March 12–13. At 8 p.m. of March 13 this low was centered just south of the southern end of Lake Michigan. On the morning of March 14 it had moved to central Michigan and had developed a secondary. This low and its secondary then moved northeastward until the evening of March 15 when they had merged and were centered over eastern Maine. Rains over the Ohio Valley ceased during the day of March 15. The total precipitation caused by this storm is shown in chart I. It should be observed that the heaviest rain fell in the vicinity of Pittsburgh.

Generally fair weather prevailed on the 16th and 17th. On the morning of the 17th a *low* was centered over Colorado which moved slowly east-southeastward and caused rains to set in over the Ohio Valley during the night of March 17–18. On the evening of the 19th this low was centered over western Kentucky, whence it moved slowly north-northeastward. At most places in the Ohio Valley rains ceased on the 21st. The precipitation caused by this storm is shown in chart II. It should be noticed that the heaviest rain fell around Cincinnati just in time for the run-off from the region of heaviest rainfall to reinforce the crest coming from Pittsburgh. Chart III shows the total precipitation caused by both storms.

While the great flood of 1913 occurred at almost the same time of the year as this flood, the storms which caused the precipitation show no similarity. In 1913 the heavy rains were caused by a storm which developed a trough of low pressure. This trough of low pressure moved very slowly, and rain continued for nearly 5 days. No other heavy rains occurred until the flood waters subsided.

Although the flood of 1933 was, in general, the highest in the Ohio Valley since 1913, and in spite of the fact that it came on with great suddenness, it was not a very disastrous flood. A detailed statement of damage caused will be published at the end of this year. The total damage approximates $2,000,000. This low figure is the combined result of flood protection works and the promptness with which the Weather Bureau issued, and the general public heeded, flood warnings.

The following excerpts of reports from officials in charge are of much interest.

Pittsburgh, Pa.—Heavy rainfall over the Pittsburgh district on March 13, with locally heavy downpours in the Monongahela Basin, during the afternoon and night of the 13th, caused rising rivers throughout the district, with a notably rapid rise in the Monongahela River and its tributaries. At Lock No. 7, Greensboro, Pa., the Monongahela River rose 21.0 feet in the 24 hours ending at 8 a.m. of the 14th, and at Pittsburgh, the Monongahela and Ohio Rivers rose at an average rate of 1 foot an hour from 5 a.m. to 1 p.m. of the 14th.

This amazingly rapid rise and the resulting swift current in the Monongahela side of the Pittsburgh Harbor was the cause of by far the greater portion of the damage sustained, as a result of the flood in the Pittsburgh district. Fleets of loaded coal and sand barges, towboats, and dredge boats broke away from their moorings at Pittsburgh. Many of them were either beached or sunk in the channel by the swift current.

Cincinnati, Ohio.—On the morning of March 13, 1933, the Ohio River in the Cincinnati district was at a nearly normal stage. The stage at Cincinnati at 8 a.m. was 22.3 feet and the average during the last 20 years has been 25 feet. In the upper portion the river stages were as low as 7.8 feet at Dam No. 12 near Wheeling, W.Va.

Quite general rains started throughout the Ohio Valley on the morning of the 13th and continued during the 14th and ended at most places in the early morning of the 15th. These rains were

Chart I. Precipitation in Ohio Valley, March 13-16, 1933

Chart I. Precipitation in Ohio Valley, March 13-16, 1933

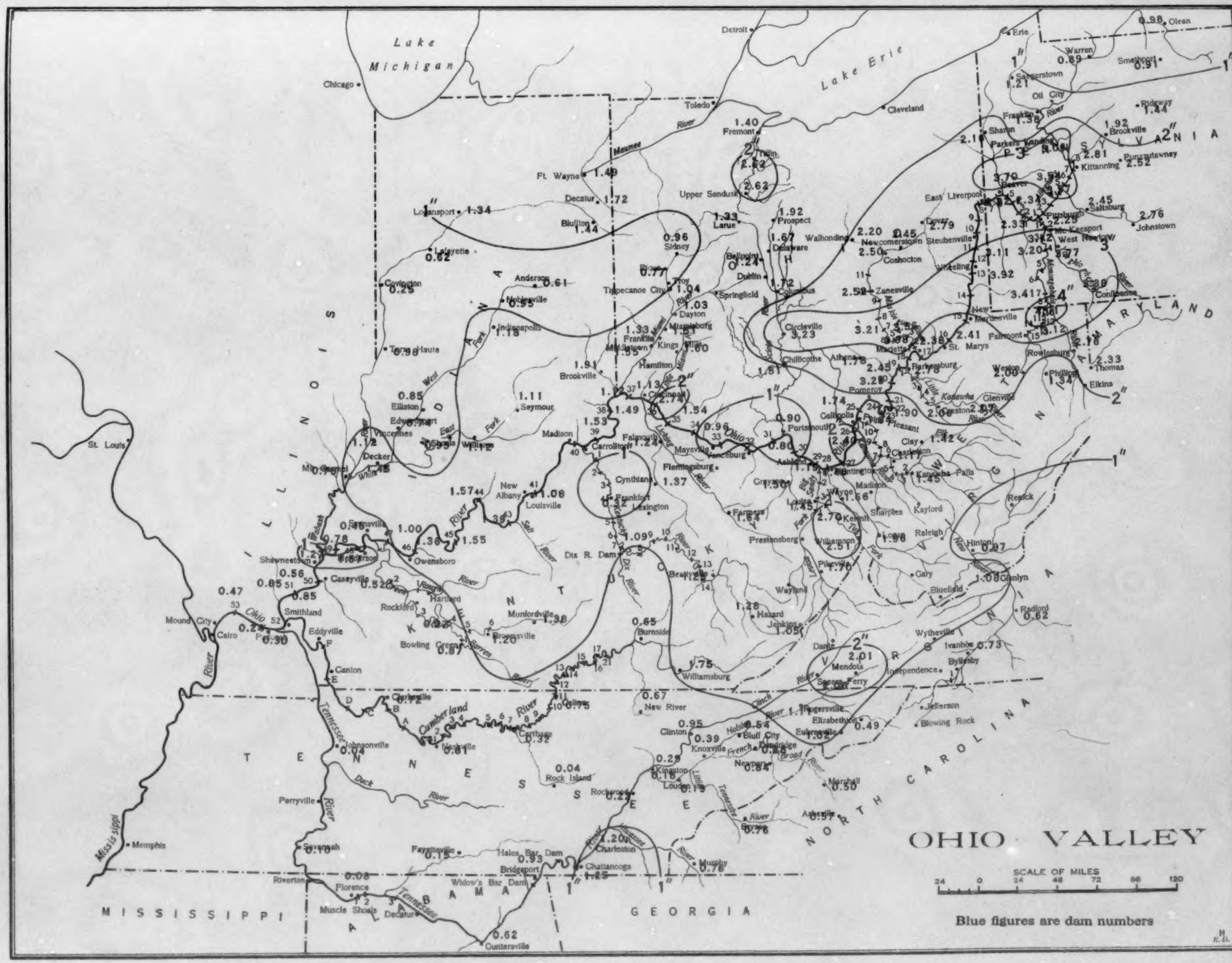


Chart II. Precipitation in Ohio Valley, March 17-20, 1933

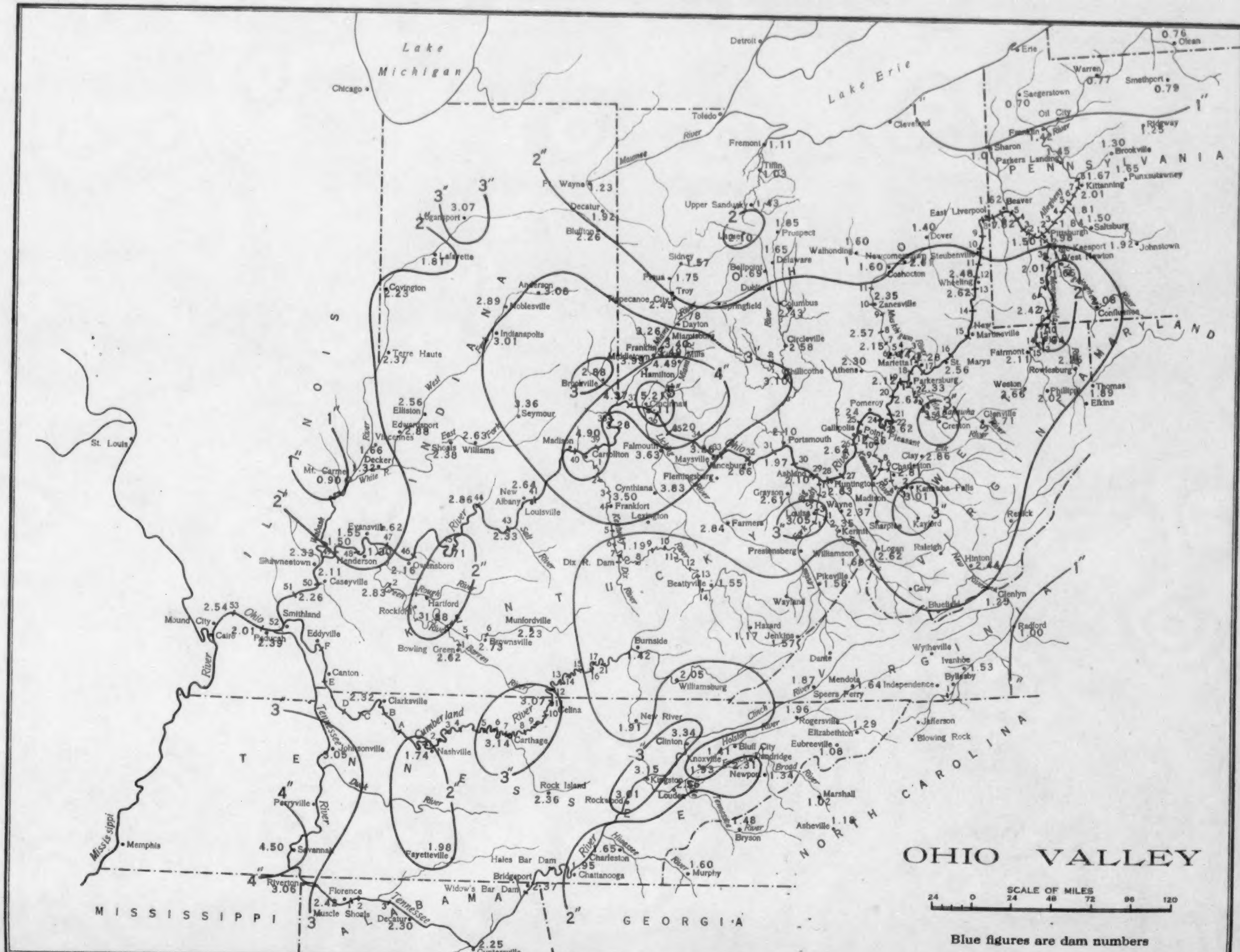
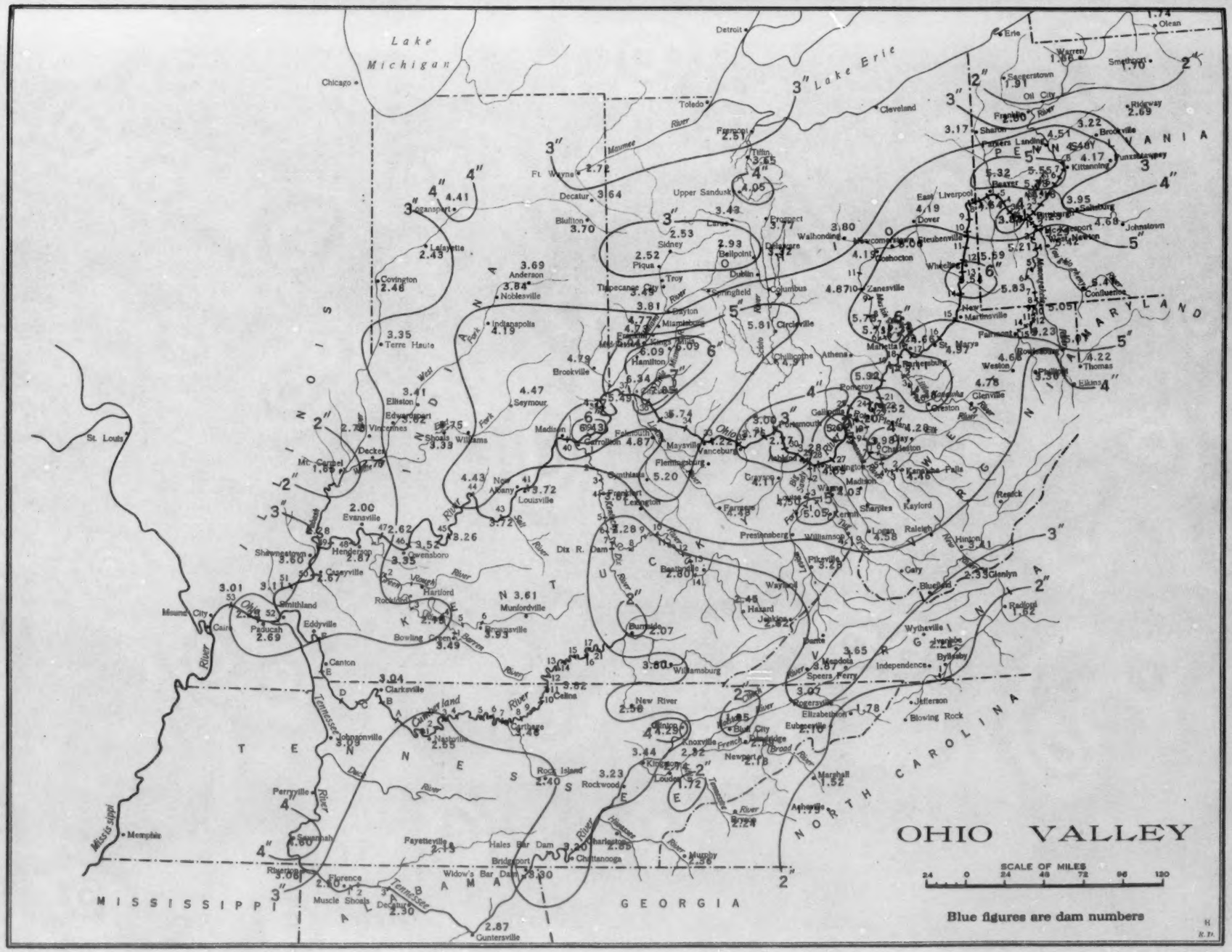


Chart III. Precipitation in Ohio Valley, March 13-20, 1933

Chart III. Precipitation in Ohio Valley, March 13-20, 1933


OHIO VALLEY
SCALE OF MILES
24 0 24 48 72 96 120
Blue figures are dam numbers
Lake Michigan
Chicago
Detroit
Toledo
Cleveland
Erie
Pittsburgh
Columbus
Cincinnati
Louisville
Nashville
Knoxville
Chattanooga
Memphis
St. Louis
Evansville
Indianapolis
Dayton
Springfield
Zanesville
Parkersburg
Huntington
Charleston
Lexington
Frankfort
Bowling Green
Paducah
Cairo
Mt. Carmel
Terre Haute
Fort Wayne
Lafayette
Decatur
Bluffton
Sidney
Piqua
Troy
Xenia
Hamilton
Middletown
Brookville
Seymour
Madison
Vincennes
Shawneetown
Hendersonville
Owensboro
Hartford
Rockport
Smithland
Eddyville
Mayfield
Murray
Clarksville
Springfield
Gallatin
Carrollton
Maysville
Vanceburg
Flemingsburg
Ashland
Portsmouth
Gallipolis
Pomeroy
Athens
Chillicothe
Marietta
Cambridge
Coshocton
Steubenville
Wheeling
Martinsville
Fairmont
Clarksburg
Weston
Glenville
Sutton
Elkins
Thomas
Kanawha Falls
Beckley
Princeton
Bluefield
Pikeville
Hazard
Jenkins
Whitesburg
Wayland
Burnside
Somerset
Williamsburg
Corbin
London
Barbourville
Middlesboro
Harlan
Pineville
Wytheville
Bristol
Abingdon
Jonesville
Gate City
Big Stone Gap
Norton
Kingsport
Johnson City
Elizabethton
Rogersville
Greeneville
Morristown
Newport
Asheville
Marshall
Hot Springs
Jefferson
Blowing Rock
Boone
Lenoir
Statesville
Mocksville
Salisbury
Concord
Charlotte
Rock Hill
Gaffney
Spartanburg
Greenville
Anderson
Walhalla
Clemson
Greenwood
Abbeville
Laurens
Union
Newberry
Columbia
Camden
Florence
Darlington
Dillon
Bennettsville
Cheraw
Hamlet
Rockingham
Wadesboro
Monroe
Lancaster
Chester
Winnsboro
Kershaw
Sumter
Manning
Georgetown
Conway
Myrtle Beach
Lake City
Kingstree
Andrews
Hemingway
Lake City
Florence
Muscle Shoals
Decatur
Guntersville
Bridgeport
Hales Bar Dam
Widow's Bar Dam
Chickamauga Dam
Wilson Dam
Pickwick Landing Dam
Kentucky Dam
Dix R. Dam
Norris Dam
Cumberland River
Tennessee River
Ohio River
Kanawha River
New River
Big Sandy River
Licking River
Scioto River
Muskingum River
Hocking River
Miami River
Wabash River
White River
Green River
Kentucky River
Big Sandy River
Guyandotte River
Tug Fork
Pocatalico River
Elk River
Gauley River
Greenbrier River
Monongahela River
Youghiogheny River
Allegheny River
Beaver River
Shenango River
Mahoning River
Grand River
Maumee River
Sandusky River
Cuyahoga River
Chagrin River
Grand River
Ashtabula
Conneaut
Fairport
Painesville
Willoughby
Lorain
Sandusky
Port Clinton
Toledo
Fremont
Tiffin
Findlay
Bellefontaine
Urbana
Springfield
Xenia
Middletown
Hamilton
Cincinnati
Batavia
Georgetown
Madison
Versailles
Greenville
Piqua
Troy
Dayton
Miamisburg
Franklin
Lebanon
Wilmington
Washington C. H.
Chillicothe
Portsmouth
Ironton
Huntington
Point Pleasant
Parkersburg
Marietta
Zanesville
Cambridge
Coshocton
Newark
Mansfield
Ashland
Wooster
Orrville
Akron
Canton
Massillon
Alliance
Salem
East Liverpool
Steubenville
Wheeling
Moundsville
New Martinsville
St. Marys
Fairmont
Clarksburg
Weston
Buckhannon
Elkins
Thomas
Davis
Parsons
Richwood
Summersville
Gauley Bridge
Montgomery
Charleston
Kanawha Falls
Beckley
Princeton
Bluefield
Welch

not unusually heavy over the middle portion of the Ohio Valley, the average amounts being less than 1½ inches, but were moderately heavy over the upper portion of the valley, the amount being over 3 inches at a few stations.

As a result of these rains the Ohio River rose quite rapidly and passed the flood stage in the Pittsburgh district. The crest of the rise from the headwaters reached the Cincinnati district at the mouth of the Kanawha on the morning of March 18. This water was not quite sufficient to fill the river in the extreme upper portion of this district as the stages at both Dams 27 and 28 were from 3 to 4 feet below flood stage, but with the addition of some water out of the Big Sandy, the stage at Dam No. 29, Ashland, Ky., reached and passed flood stage by 6 inches. Without the addition of more water the crest stage would have been very near flood stage from Dam 29 to Dam 39.

None of the tributaries which enter the Ohio River in the Cincinnati district were in flood during the first storm, although both the Big Sandy and the Licking ran out fairly strong. The Kanawha-New River continued low and there was very little rise in the Big Miami.

The weather map on the morning of March 18 showed a well-defined depression central over Kansas and extending eastward across the Ohio Valley. This type of map was favorable for general rains in the Ohio Valley, but the indications were not for heavy or excessive rains. However, the rains did come both heavy and excessive and with greatest intensity in the immediate vicinity of Cincinnati. The greatest rainfall in 36 hours was nearly 5 inches, and the rainfall was at the rate of 1 inch per hour for a considerable time. These excessive rains extended about 100 miles both up and down the river from Cincinnati and some 50 miles southward into Kentucky, and northeastward in the Little Miami Valley. Some portions of the Kanawha Valley in West Virginia received 3 inches or more, but as a rule the rainfall was not unusually heavy from Portsmouth up to the mouth of the Kanawha. The precipitation in this last storm was comparatively light over the headwaters of the Kentucky tributaries and also those of the Ohio which enter the Ohio River in the Cincinnati district.

These last excessive rains caused an unusually rapid rise in the Ohio at Cincinnati. The river reached and passed flood stage at 10 p.m. March 18 and finally reached the crest stage of 63.6 feet at 5 p.m. March 21. It rose 11.1 feet in 24 hours from March 18 to March 19, an unusually rapid rise when the river is above the flood stage.

Louisville, Ky.—The unusually rapid rise of March 19 and 20 caused much apprehension even on the part of those affected only by the highest floods. As the flood developed many rumors and unauthorized reports became current, resulting in much labor in denying and correcting them. This was due partly to the relatively long period of comparative security enjoyed by the dwellers on the low sections; for the present flood was the highest since 1913 and the first of major proportions since January 1927. The usual uneasiness in regard to the river had become allayed during the long period of deficient precipitation. When aroused by the sharp rise on a river almost at flood stage, the people were ready to credit the wildest rumors.

Very heavy rains fell over Southern Ohio and Northern Kentucky on May 13 and 14. At this time Cincinnati, Ohio, received its greatest 24-hour rainfall of record, viz, 5.50 inches. This narrow strip of heavy rainfall caused the Ohio to reach the flood stage immediately thereafter, although several of the tributaries did not reach the flood stage. While this flood was considerably lower than that of March 1933 it is noteworthy because the crest stage at Cincinnati, 54.1, was the highest on record between May 1 and December 1, except for the August flood in 1875, when the crest stage was 55.4 feet.

White Basin

A severe flood occurred in the Black River in April and another one in May. These two floods were exceeded only by the August 1915 and April 1927 floods. A moderate flood occurred in the White River in May.

Arkansas Basin

There were minor floods in the lower Arkansas River in March and April, and in the Petit Jean River in April. In addition, heavy rains in Kansas and Oklahoma from May 12 to May 15 caused overflows in all of the smaller streams, and slight floods in the Verdigris, Neosho, Canadian, and Arkansas Rivers.

Red Basin

The Red River had no flood, but several overflows occurred in the Sulphur, a tributary of the Red.

The absence of appreciable floods in the Missouri, Arkansas, and Red Basins lessened the criticalness of floods in the lower Mississippi. If the Ohio and upper Mississippi floods had been reinforced by large floods in the Missouri, Arkansas, and Red Rivers there would have been a major flood in the lower Mississippi.

Lower Mississippi Basin

Severe floods occurred in the St. Francis River in both April and May. That of April caused 4 breaks in the levees, while that of May caused 19 breaks. The crest stage in May at Chaonia, Mo., was within 1.5 feet of the highest water of record. At Fisk, Mo., and St. Francis, Ark., the crests of May were the highest stages of record. Considerably higher water would have occurred at the lower stations on this river if there had been no breaks in the levees.

The flood in the Tallahatchie-Yazoo Rivers lasted for 6 months and reached high stages. The crest at Swan Lake, Miss., was exceeded only by the flood of 1932. The crest at Greenwood, Miss., was exceeded by the floods of 1882, 1927, and 1932. There were no rises of importance in the Ouachita River.

There were two distinct rises in the lower Mississippi River. The first lasted from March 26 to about the middle of May, and was principally the result of the first rise in the Ohio River. The second lasted from the middle of May to June 19 and was principally the result of the third rise in the Ohio River and the nearly simultaneous overflows in the upper Mississippi River. The lower Mississippi River did not pass below the flood stage at all points between these two rises.

Both of these overflows were considerably lower than the flood of 1929. (See "The Flood of 1929 in the Lower Mississippi Valley", p. 317, vol. 57, M. R. W., 1929.) However, they caused considerable damage, the total reported for the entire lower Mississippi Basin being $6,893,253.

Although crevasses occurred in the levees of the St. Francis and Tallahatchie-Yazoo Rivers, there were none in the levees of the lower Mississippi River. Furthermore, it is of interest to note that below Helena, Ark., the second rise was larger than the first, while above this place, the first rise was larger than the second. This was due to the fact that the Arkansas River was considerably higher during the second rise than it was during the first rise.

Atchafalaya Basin

From the point of view of damage caused, the flood in the Atchafalaya River was of minor consequence. However, the river reached the second highest stage since the great flood of 1927 at the Atchafalaya, La., gage. In fact, the 1932 stage at this gage exceeded the 1927 stage, and since this significant occurrence was not commented upon in the MONTHLY WEATHER REVIEW during 1932, a few comments will be proper here. The official in charge of the New Orleans, La., Weather Bureau office writes as follows:

The recent changes in the Atchafalaya River, especially since the extension of levees along a considerable part of the river, are very interesting. Aside from the fact that a considerable part of the

Atchafalaya Basin flow in 1927 was outside the broken-down levees, it is a fact that deposits below Atchafalaya, La., have resulted in higher stages than formerly at that point, and more backwater in the open area between the levees that are near the river and the levees that are placed back several miles from the river.

When the Atchafalaya is high, the natural slope in the middle portion is considerably steeper than in the extreme upper portion or the lower portion. This condition, after the levees were constructed, has enabled the river to scour its channel very effectively even to a point not less than 6 miles below Atchafalaya, the scour thus extending slightly farther south than the levees near the river. The extent of this channel erosion is indicated by the following table, from "The Improvement of the Lower Mississippi River for Flood Control and Navigation", volume I, page 53 (prepared under the direction of the president of the Mississippi River Commission, by D. O. Elliot, major, Corps of Engineers):

Comparative channel areas—Below bankful stage

[Barbre Landing (0 mile) to Butte La Rose (66.9 miles)]

Reach	Miles below Barbre Landing	Surveys				
		1880-81	1904-5	1916-17	1927	1931
		Square feet	*Square feet*	*Square feet*	*Square feet*	*Square feet*
A	0-13.7	53,200	55,600	62,200	77,200	65,400
B	13.7-29.8	40,700	55,900	63,200	77,600	71,600
C	29.8-36.9	32,200	50,700	56,300	64,100	59,000
D	36.9-43.0	22,100	32,300	40,200	56,600	55,100
E	43.0-52.0	----------	18,900	40,000	65,400	59,700
F	52.0-63.7	----------	14,000	21,600	33,200	34,600
G	63.7-66.9	----------	14,000	16,700	17,300	22,900

Simmesport is 5 miles below the head of the river at Barbre Landing, Melville 31 miles below, and Atchafalaya 61.6.

Comments on the above table appear in the publication above referred to, as follows:

"Table V indicates the extent to which channel enlargement has followed the extension of the Atchafalaya River levees. It will be noted that the channel enlargement reached its maximum in 1927 and that since that date there has been an appreciable deterioration in average channel cross section from Reach A to Reach E, inclusive. Reaches F and G have enlarged since 1927. This observed channel deterioration is readily explained by the fact that the year 1927 was an abnormal flood year, which has until the present (December 31, 1931) been followed by only one flood (1929). The flood of 1927 caused a greater channel enlargement than the river could subsequently maintain. Deterioration was therefore inevitable. The fact that the channel through Reaches F and G has continued to enlarge since 1927 is explained by the fact that these reaches are generally unleveed. The effect of the 1927 flood on the channel through these reaches was therefore much less pronounced than in the leveed reaches above."

The following in reference to silting in the lower Atchafalaya Basin is quoted from page 56 of the same publication:

"Below the lower limit of Atchafalaya Levee influence silting is taking place in the Atchafalaya Basin. This silting is probably more extensive now than it was before the channel enlargement permitted a marked increase in the volume of the Atchafalaya discharge. The Atchafalaya presents an interesting study in the development of an alluvial stream. The river is now silting up the existing Mississippi River Delta which it must cross before it can push its own channel to the sea and undertake the construction of its own delta. At present the flow of the Atchafalaya is dissipated in a network of inefficient channels in the lower portion of the basin. When, however, this sedimentation has raised the surface of the basin to a sufficient elevation, the river will be forced to develop an efficient channel and push it to the sea."

The effect of the changes that have taken place on stages at Atchafalaya as related to Melville stages is shown by the following table, giving highest stages from 1927 to 1933:

Station	1927	1928	1929	1930	1931	1932	1933
Simmesport	53.4	37.8	46.4	35.8	29.8	47.7	41.2
Melville	46.8	37.6	42.2	35.0	30.5	42.8	38.3
Atchafalaya	24.6	21.6	22.6	22.3	22.4	24.9	24.1
Difference Melville-Atchafalaya	22.2	16.0	19.6	12.7	8.1	17.9	14.2

We may compare stages in 1932 with those in 1929 with Melville 1932 higher than 1929 by 0.6 foot and the difference between Melville and Atchafalaya 1.7 feet less than in 1929. Or we may compare 1933 with 1928, with Melville 0.7 foot higher than in 1928, and the difference between Melville and Atchafalaya 1.8 feet less than in 1928.

The progressive character of the changes that are taking place may be noted by comparing the stage at Melville with the stage at Atchafalaya when the stage of 22 feet is reached at Atchafalaya in successive years. After the stage of 22 feet is passed at Atchafalaya the increase in overflow makes the rate of further rise slow. But the southward escape of the water is so retarded by the silting referred to that stages at Atchafalaya increase progressively in relation to stages at Melville.

WEST GULF OF MEXICO DRAINAGE

Several minor overflows occurred in the Trinity River in Texas. There was also a minor overflow in the headwaters of the Rio Grande.

GULF OF CALIFORNIA DRAINAGE

There was a flood of small importance in the Colorado River and some of its tributaries in May and June.

GENERAL REMARKS

All the floods mentioned above were forecast by the Weather Bureau in advance, and considerable property was saved. In the Mississippi system $6,604,782 worth of property was saved as a result of flood warnings during the 4 months under discussion. Outside of the Mississippi system $454,202 worth of property was saved.

Four persons were drowned by the flood waters of rivers of the upper Mississippi Basin, and one by the flood of the Scioto, a tributary of the Ohio.

Below is a table showing the crests reached and the time the water was above flood stage for all of the Weather Bureau gages where floods occurred in these 4 months.

Table of flood stages March to June, inclusive, 1933

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ST. LAWRENCE DRAINAGE					
Red Cedar:	*Feet*			*Feet*	
Williamston, Mich.	6	Apr. 2	Apr. 3	7.5	Apr. 2.
East Lansing, Mich.	8	---do---	---do---	9.1	Do.
Grand:					
Eaton Rapids, Mich.	5	Apr. 3	Apr. 4	5.0	Apr. 3-4.
Grand Ledge, Mich.	7	Mar. 16	Mar. 16	7.0	Mar. 16.
		Apr. 3	Apr. 3	7.0	Apr. 3.
Flint: Columbiaville, Mich.	8	Apr. 2	Apr. 6	9.8	Do.
		Apr. 20	Apr. 21	8.4	Apr. 20.
Pine: Alma, Mich.	6	May 2	May 2	6.9	May 2.
Chippewa: Mount Pleasant, Mich.	12	May 3	May 3	12.1	May 3.
Tittabawassee:					
Midland, Mich.	18	Apr. 19	Apr. 19	18.6	Apr. 19.
		May 3	May 3	20.5	May 3.
Shields, Mich.	10	---do---	May 7	15.5	May 3-4.
St. Joseph: Fort Wayne, Ind.	12	Mar. 15	Mar. 15	12.1	Mar. 15.
		May 9	May 12	13.3	May 12.
Maumee: Fort Wayne, Ind.	15	---do---	May 14	17.3	Do.
Sandusky:					
Upper Sandusky, Ohio	13	Mar. 14	Mar. 15	14.8	Mar. 14.
Tiffin, Ohio	7	---do---	Mar. 14	7.1	Do.
Fremont, Ohio	11	Mar. 15	Mar. 15	12.8	Mar. 15.
ATLANTIC SLOPE DRAINAGE					
Connecticut:					
Woodsville, N.H.	12	Apr. 18	Apr. 21	15.4	Apr. 19.
White River Junction, Vt.	18	---do---	Apr. 23	24.3	Do.
Holyoke, Mass.	10	---do---	---do---	12.4	Apr. 20.
Springfield, Mass.	20	Apr. 20	Apr. 20	20.0	Do.
Hartford, Conn.	16	Apr. 8	Apr. 26	26.0	Apr. 21.
Schuylkill: Reading, Pa.	10	Apr. 17	Apr. 18	11.0	Apr. 17.
North Branch: Cumberland, Md.	17	Mar. 14	Mar. 14	17.9	Mar. 14.
Potomac: Sycamore Island, Md.	10	Apr. 22	Apr. 22	12.0	Apr. 22.

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE—contd.					
James:	*Feet*			*Feet*	
Columbia, Va.	15	Mar. 21	Mar. 22	18.5	Mar. 21.
		Apr. 17	Apr. 21	25.8	Apr. 18.
Richmond, Va.	8	Mar. 22	Mar. 22	8.1	Mar. 22.
		Apr. 18	Apr. 20	14.1	Apr. 19.
Roanoke:					
Weldon, N.C.	31	...do...	Apr. 19	32.0	Apr. 18.
Williamston, N.C.	10	Mar. 26	Mar. 29	10.3	Mar. 27-28.
		Apr. 21	May 2	10.9	Apr. 26.
Neuse: Smithfield, N.C.	14	Apr. 18	Apr. 21	16.5	Apr. 19.
Santee:					
		Feb. 9	Mar. 3	15.2	Feb. 24.
		Mar. 11	Mar. 12	12.2	Mar. 12.
Rimini, S.C.	12	Mar. 22	Mar. 27	13.8	Mar. 25.
		June 4	June 4	12.0	June 4.
		June 17	June 17	12.0	June 17.
		Feb. 9	Mar. 6	13.7	Feb. 24-27.
Ferguson, S.C.	12	Mar. 24	Mar. 30	12.8	Mar. 27.
		Feb. 9	Mar. 4	19.5	Feb. 23.
		Mar. 10	Mar. 12	14.8	Mar. 10.
Savannah: Ellenton, S.C.	14	Mar. 22	Mar. 26	15.7	Mar. 23-24.
		Apr. 19	Apr. 22	15.3	Apr. 20.
		May 10	May 11	14.3	May 11.
		June 27	June 28	14.5	June 28.
Ogeechee:					
Dover, Ga.	7	Feb. 8	Mar. 5	8.1	Feb. 22-24.
Meldrim, Ga.	9	Feb. 9	Mar. 10	10.6	Feb. 26-28.
Ocmulgee: Abbeville, Ga.	11	Feb. 23	Mar. 2	13.4	Feb. 27.
Altamaha:					
Charlotte, Ga.	12	Jan. 28	Mar. 8	17.0	Mar. 2-3.
		Mar. 23	Mar. 29	12.5	Mar. 28.
Everett City, Ga.	10	Feb. 11	Mar. 11	10.8	Mar. 6-7.
EAST GULF OF MEXICO DRAINAGE					
Chattahoochee: Alaga, Ala.	30	Mar. 21	Mar. 23	33.2	Mar. 22.
Apalachicola:					
River Junction, Fla.	20	Mar. 24	Mar. 24	20.1	Mar. 24.
Blountstown, Fla.	15	Jan. 28	Mar. 15	20.4	Feb. 25.
		Mar. 21	Apr. 25	21.0	Mar. 25.
Choctawhatchee:					
Newton, Ala.	19	Mar. 20	Mar. 22	23.8	Mar. 21.
Geneva, Ala.	23	Mar. 22	Mar. 25	25.4	Mar. 22.
Caryville, Fla.	12	...do...	Mar. 27	13.7	Mar. 24.
		Apr. 15	Apr. 19	13.0	Apr. 16.
Conecuh: Brewton, Ala.	17	Mar. 24	Mar. 27	18.0	Mar. 26.
Coosa:					
Gadsden, Ala.	22	Mar. 22	Mar. 22	22.0	Mar. 22.
Lock No. 4, Lincoln, Ala.	17	Mar. 21	...do...	18.0	Mar. 21.
Cahaba: Centerville, Ala.	23	Mar. 20	Mar. 21	28.0	Mar. 20.
Alabama:					
Montgomery, Ala.	35	Mar. 21	Mar. 25	43.1	Mar. 23.
Selma, Ala.	35	...do...	Mar. 28	45.0	Mar. 24.
Millers Ferry, Ala.	35	Feb. 21	Mar. 1	42.4	Feb. 25-26.
		Mar. 21	Mar. 30	47.8	Mar. 26.
Black Warrior: Lock No. 10, Tuscaloosa, Ala.	46	...do...	Mar. 21	46.4	Mar. 21.
Tombigbee:					
Aberdeen, Miss.	34	...do...	Mar. 22	35.0	Do.
		Apr. 3	Apr. 3	34.5	Apr. 3.
Lock No. 4, Demopolis, Ala.	39	Mar. 21	Apr. 4	46.5	Mar. 26.
		Apr. 15	Apr. 22	43.7	Apr. 19.
Lock No. 3, Ala.	33	Mar. 9	Mar. 13	35.0	Mar. 11.
		Mar. 20	Apr. 25	48.7	Mar. 27.
Lock No. 2, Ala.	46	Mar. 22	Apr. 4	49.0	Apr. 2.
		Apr. 15	Apr. 22	48.6	Apr. 17.
Lock No. 1, Ala.	31	Mar. 21	Apr. 27	35.7	Apr. 2, 3, 18.
Pascagoula: Merrill, Miss.	18	Apr. 15	Apr. 25	19.6	Apr. 16.
Pearl:					
		Feb. 8	Mar. 14	25.0	Feb. 16-17.
Jackson, Miss.	20	Mar. 23	Apr. 1	22.4	Mar. 28.
		Apr. 13	Apr. 19	27.0	Apr. 21-22.
		Mar. 2	Mar. 2	15.5	Mar. 2.
Monticello, Miss.	15	Apr. 1	Apr. 4	20.2	Apr. 1.
		Apr. 14	Apr. 29	21.7	Apr. 21.
		Apr. 3	Apr. 5	20.0	Apr. 4.
Columbia, Miss.	18	Apr. 15	Apr. 28	22.9	Apr. 23.
		...do...	Apr. 17	12.6	Apr. 16.
Bogue Chitto: Franklinton, La.	10	Apr. 20	Apr. 23	12.0	Apr. 20.
		May 2	May 4	17.0	May 2.
West Pearl: Pearl River, La.	13	Feb. 14	Mar. 25	15.4	Mar. 1.
		Apr. 1	May 12	16.7	May 5.
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
Rock: Moline, Ill.	10	Apr. 4	Apr. 12	10.3	Apr. 9.
		May 9	June 3	11.8	May 30.
Cedar: Cedar Rapids, Iowa.	13	Apr. 3	Apr. 5	18.7	Apr. 4.
Iowa:					
Iowa City, Iowa.	8	Apr. 9	Apr. 13	10.0	Apr. 10.
		May 24	May 28	8.8	May 26.
Wapello, Iowa.	7	Apr. 5	Apr. 15	15.4	Apr. 7.
		May 22	May 27	9.2	May 24.
Des Moines:					
Boone, Iowa.	20	Mar. 31	Apr. 4	24.4	Apr. 2.
Tracy, Iowa.	14	Apr. 5	Apr. 8	16.6	Apr. 6.
Ottumwa, Iowa.	9	Apr. 4	Apr. 9	11.8	Apr. 8.

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Upper Mississippi Basin—Contd.					
Illinois:	*Feet*			*Feet*	
Morris, Ill.	13	Apr. 1	Apr. 7	19.2	Apr. 2.
		May 9	May 18	18.3	May 14.
Peru, Ill.	17	Apr. 1	Apr. 24	21.6	Apr. 3.
		May 6	June 4	23.8	May 15.
Henry, Ill.	10	Mar. 30	June 10	18.7	May 18.
Peoria, Ill.	18	Apr. 2	Apr. 27	22.3	Apr. 8.
		May 6	June 7	25.4	May 18.
Havana, Ill.	14	Mar. 28	June 17	23.1	May 23.
Beardstown, Ill.	14	...do...	June 19	25.5	Do.
Pearl, Ill.	12	Apr. 1	June 18	20.8	May 29, 30.
Bourbeuse: Union, Mo.	12	May 14	May 17	17.5	May 16.
Meramec:					
Steelville, Mo.	12	Apr. 16	Apr. 16	15.0	Apr. 16.
		May 14	May 15	17.0	May 14.
		Apr. 17	Apr. 19	17.0	Apr. 18.
Pacific, Mo.	11	May 14	May 18	22.9	May 16.
		May 26	May 27	13.0	May 26.
		Apr. 17	Apr. 19	21.5	Apr. 18.
Valley Park, Mo.	14	May 14	May 19	28.0	May 17.
		May 26	May 27	15.3	May 26.
Mississippi:					
Keokuk, Iowa.	12	Apr. 7	Apr. 13	14.5	Apr. 9, 10.
		May 26	May 29	13.7	May 26.
		Apr. 8	Apr. 13	16.1	Apr. 10.
Quincy, Ill.	14	May 14	May 14	14.5	May 14.
		May 26	May 29	15.6	May 27.
		Apr. 8	Apr. 17	15.9	Apr. 10.
Hannibal, Mo.	13	May 13	May 16	14.8	May 14.
		May 26	May 30	15.8	May 27.
		Apr. 8	Apr. 18	14.4	Apr. 11.
Louisiana, Mo.	12	May 13	May 17	15.0	May 15.
		May 26	May 31	15.2	May 28.
		Apr. 12	Apr. 14	18.5	Apr. 13.
Grafton, Ill.	18	May 15	May 19	20.4	May 17.
		May 25	June 2	20.7	May 30.
		May 15	May 19	23.4	May 16.
Alton, Ill.	21	May 26	June 1	23.2	May 30.
		May 16	May 20	28.9	May 18.
Chester, Ill.	27	May 29	June 1	27.6	May 31.
		May 16	May 22	34.4	May 19.
Cape Girardeau, Mo.	32	May 28	June 1	32.5	May 30, 31.
Missouri Basin					
Soloman: Beloit, Kans.	18	Apr. 22	Apr. 22	18.6	Apr. 22.
Grand: Chillicothe, Mo.	18	May 26	May 26	18.3	May 26.
Missouri: St. Charles, Mo.	25	May 14	May 14	25.1	May 14.
Ohio Basin					
Alleghany:					
Lock No. 5, Schenley, Pa.	24	Mar. 15	Mar. 16	29.0	Mar. 15.
Lock No. 4, Natrona, Pa.	24	...do...	do...	26.6	Do.
Lock No. 3, Springdale, Pa.	27	...do...	...do...	27.4	Do.
Youghiogheny: Confluence, Pa.	10	Mar. 14	Mar. 14	12.0	Mar. 14.
Monongahela:					
Lock No. 7, Greensboro, Pa.	30	...do...	...do...	34.4	Do.
Lock No. 4, Pa.	31	...do...	...do...	32.3	Do.
McKeesport, Pa.	16	...do...	...do...	16.9	Do.
Beaver:					
Sharon, Pa.	9	...do...	Mar. 16	10.8	Mar. 15.
Beaver Falls, Pa.	11	Mar. 15	Mar. 15	11.7	Do.
		Mar. 14	Mar. 16	12.3	Do.
Walhonding: Walhonding, Ohio	8	Mar. 19	Mar. 22	11.8	Mar. 21.
		May 14	May 15	13.4	May 14.
Tuscarawas:					
Dover, Ohio.	9	Mar. 16	Mar. 16	9.6	Mar. 16.
Newcomerstown, Ohio.	11	...do...	Mar. 18	13.6	Mar. 17.
Coshocton, Ohio.	8	Mar. 15	Mar. 24	14.2	Do.
		May 14	May 16	12.7	May 15.
Muskingum:					
Lock No. 10, Zaneville, Ohio.	25	Mar. 19	Mar. 20	26.5	Mar. 19.
Lock No. 7, McConnelsville, Ohio.	22	Mar. 16	Mar. 22	26.5	Do.
		May 15	May 16	23.8	May 15.
Lock No. 4, Beverly, Ohio.	25	Mar. 19	Mar. 20	28.0	Mar. 19.
Lock No. 3, Lowell, Ohio.	25	Mar. 17	Mar. 21	28.2	Mar. 20.
Lock No. 1, Marietta, Ohio.	28	Mar. 15	Mar. 22	34.6	Mar. 16.
		Mar. 15	Mar. 16	19.5	Mar. 15.
Hocking: Athens, Ohio.	17	Mar. 20	Mar. 21	19.1	Mar. 20.
		May 15	May 16	20.0	May 15.
Olentangy: Delaware, Ohio.	9	Mar. 14	Mar. 15	9.2	Mar. 14.
		May 14	May 14	13.0	May 14.
Scioto:		Mar. 15	Mar. 15	11.2	Mar. 15.
La Rue, Ohio.	11	Mar. 20	Mar. 21	11.3	Mar. 20.
		May 12	May 12	11.3	May 12.
		May 14	May 14	12.5	May 14.
Prospect, Ohio.	10	Mar. 21	Mar. 21	10.7	Mar. 21.
		May 13	May 16	11.7	May 13.
Bellpoint, Ohio.	9	May 14	May 14	11.6	May 14.
		Mar. 20	Mar. 22	13.6	Mar. 20.
Circleville, Ohio.	10	Apr. 13	Apr. 13	10.3	Apr. 13.
		Apr. 19	Apr. 20	11.4	Apr. 20.
		May 12	May 17	17.3	May 15.
Chillicothe, Ohio.	16	Mar. 21	Mar. 23	19.2	Mar. 21.
		May 13	May 17	22.8	May 16.
Little Miami: Kings Mills, Ohio.	17	Mar. 19	Mar. 19	24.3	Mar. 19.
		May 14	May 14	22.1	May 14.
Licking: Falmouth, Ohio.	28	Mar. 19	Mar. 19	28.5	Mar. 19.
Stillwater: Pleasant Hill, Ohio.	13	May 12	May 14	17.0	May 13.

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Ohio Basin—Continued					
Miami:	*Feet*			*Feet*	
Sidney, Ohio	12	May 13	...do...	13.7	Do.
Franklin, Ohio	16	May 15	May 15	16.1	May 15.
Middletown, Ohio	15	Mar. 19	Mar. 20	15.0	Mar. 19, 20.
		May 14	May 15	17.4	May 15.
Barren: Bowling Green, Ky	20	Mar. 21	Mar. 22	23.2	Mar. 22.
		May 12	May 14	23.1	May 13.
Green:					
Lock No. 4, Woodbury, Ky	33	Mar. 21	Mar. 24	36.4	Mar. 22.
		May 13	May 15	35.6	May 14.
Lock No. 2, Rumsey, Ky	34	Mar. 22	Apr. 9	38.7	Mar. 26.
		May 16	May 20	35.7	May 18.
West Fork of White:					
Anderson, Ind	12	May 12	May 15	17.6	May 14.
Noblesville, Ind	14	Mar. 21	Mar. 21	14.6	Mar. 21.
		May 12	May 15	17.6	May 15.
Elliston, Ind	19	Mar. 19	Mar. 28	25.4	Mar. 23.
		Apr. 17	Apr. 22	23.1	Apr. 20.
		May 14	May 23	27.8	May 16.
Edwardsport, Ind	12	Mar. 10	Mar. 10	12.3	Mar. 10.
		Mar. 16	Apr. 26	19.2	Mar. 25.
		May 4	May 31	20.1	May 17.
East Fork of White:					
Seymour, Ind	10	Mar. 19	Mar. 23	13.5	Mar. 21.
		Apr. 18	Apr. 20	12.9	Apr. 18.
		May 14	May 17	13.7	May 15.
Williams, Ind	10	Mar. 22	Mar. 27	15.9	Mar. 24.
		Apr. 21	Apr. 23	12.7	Apr. 22.
		May 15	May 22	18.6	May 18.
Shoals, Ind	20	Mar. 22	Mar. 28	27.2	Mar. 25.
		Apr. 21	Apr. 25	23.6	Apr. 23.
		May 15	May 23	29.8	May 19.
White: Decker, Ind	18	Mar. 22	Apr. 4	23.9	Mar. 27.
		Apr. 20	Apr. 28	21.3	Apr. 25.
		May 15	May 28	26.0	May 20, 21.
Wabash:					
Bluffton, Ind	11	May 13	May 16	12.7	May 13.
Logansport, Ind	15	Mar. 21	Mar. 21	15.1	Mar. 21.
La Fayette, Ind	13	Mar. 20	Mar. 29	21.5	Mar. 22.
		Apr. 2	Apr. 3	13.8	Apr. 2-3.
		Apr. 18	Apr. 20	15.2	Apr. 19.
		May 10	May 19	22.8	May 13.
Covington, Ind	16	Mar. 20	Mar. 31	25.0	Mar. 23.
		Apr. 3	Apr. 5	17.8	Apr. 4.
		Apr. 8	Apr. 9	16.7	Apr. 9.
		Apr. 19	Apr. 22	18.6	Apr. 20-21.
		May 10	May 21	27.7	May 14.
Terre Haute, Ind	14	Mar. 20	Apr. 11	20.1	Mar. 25.
		Apr. 19	Apr. 24	15.1	Apr. 22.
		May 9	May 26	25.1	May 15.
Vincennes, Ind	14	Mar. 23	Apr. 11	18.8	Mar. 29.
		May 14	May 31	24.4	May 20.
Mt. Carmel, Ill	16	Mar. 20	Apr. 29	23.7	Mar. 29.
		May 7	June 2	26.1	May 20.
Cumberland: Lock F, Eddyville, Ky	50	Mar. 22	Mar. 29	54.7	Mar. 27.
		Apr. 1	Apr. 7	52.2	Apr. 3.
		May 15	May 19	52.4	May 18.
Pigeon: Newport, Tenn	6	May 10	May 10	8.4	May 10.
Elk: Fayetteville, Tenn	14	Mar. 19	Mar. 19	16.2	Mar. 19.
		May 8	May 13	21.5	May 11.
Ohio:					
Pittsburgh, Pa	25	Mar. 15	Mar. 16	29.6	Mar. 15.
Old Dam No. 2, Corapolis, Pa	26	...do...	...do...	27.9	Mar. 16.
Dam No. 6	30	Mar. 14	Mar. 17	37.8	Do.
Dam No. 12	36	Mar. 15	...do...	39.2	Do.
Dam No. 13	43	Mar. 16	...do...	45.0	Do.
St. Marys, W.Va	38	...do...	Mar. 18	39.6	Mar. 17.
Marietta, Ohio	33	Mar. 15	Mar. 23	41.0	Do.
Parkersburg, W.Va	36	...do...	...do...	42.4	Do.
Dam No. 19, Little Hocking, Ohio	39	Mar. 16	Mar. 22	43.1	Do.
Dam No. 22, Ravenswood, W.Va	42	...do...	Mar. 23	46.4	Mar. 18.
Dam No. 25	40	...do...	Mar. 25	51.5	Mar. 21-22.
Point Pleasant, W.Va	40	...do...	...do...	50.9	Mar. 22.
Dam No. 26	50	Mar. 19	Mar. 24	54.5	Do.
Dam No. 28, Huntington, W.Va	50	...do...	...do...	55.0	Do.
Dam No. 29, Ashland, Ky	50	Mar. 18	Mar. 25	59.6	Do.
Dam No. 30	52	Mar. 19	...do...	59.4	Do.
Portsmouth, Ohio	50	Mar. 18	Mar. 26	60.7	Do.
		May 17	May 17	50.2	May 17.
Dam No. 32	53	Mar. 20	Mar. 25	58.4	Mar. 22.
Dam No. 33	48	Mar. 18	Mar. 27	58.7	Mar. 22-23.
		May 17	May 17	48.4	May 17.
Dam No. 35, New Richmond, Ohio	45	Mar. 18	Mar. 27	56.5	Mar. 22.
		May 15	May 18	45.9	May 17-18.
Dam No. 36	50	Mar. 18	Mar. 27	61.6	Mar. 21.
		May 14	May 18	51.3	May 14.
Cincinnati, Ohio	52	Mar. 18	Mar. 27	63.6	Mar. 21-22.
		May 14	May 18	54.1	May 15.
Dam No. 37	54	Mar. 19	Mar. 28	59.3	Mar. 22.
Dam No. 38	45	...do...	...do...	58.0	Do.
		May 14	May 20	50.2	May 15.
Dam No. 39, Marland, Ind	45	Mar. 19	Mar. 28	53.6	Mar. 23.
		May 15	May 18	46.2	May 16.
Madison, Ind	46	Mar. 19	Mar. 28	54.5	Mar. 23.
		May 15	May 16	46.7	May 16.

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Ohio Basin—Continued					
Dam No. 41, Louisville, Ky.:	*Feet*			*Feet*	
Upper gage	28	Mar. 19	Mar. 29	39.1	Mar. 23.
		May 15	May 20	30.1	May 17.
Low-water gage	51	Mar. 19	Mar. 29	62.0	Mar. 24.
		May 16	May 20	53.1	May 17.
Dam No. 43	55	Mar. 19	Mar. 29	64.5	Mar. 24.
		May 17	May 18	55.6	May 17.
Dam No. 44, Leavenworth, Ind	50	Mar. 19	Mar. 30	63.0	Mar. 24.
		May 15	May 22	54.8	May 17-18.
Dam No. 45, Addison, Ky	45	Mar. 20	Mar. 31	54.2	Mar. 25.
		May 16	May 22	48.0	May 18.
Dam No. 46, Owensboro, Ky	39	Mar. 21	Apr. 1	44.0	Mar. 25-26.
		May 17	May 23	40.2	May 19.
Dam No. 47, Newburgh, Ind	35	Mar. 20	Apr. 4	45.0	Mar. 26-27.
		Apr. 19	Apr. 26	39.4	Apr. 22.
		May 15	May 26	41.9	May 20.
Evansville, Ind	35	Mar. 19	Apr. 5	45.2	Mar. 26-27.
		Apr. 19	Apr. 26	39.6	Apr. 22.
		May 15	May 26	42.3	May 20.
Dam No. 48, Cypress, Ind	35	Mar. 20	Apr. 6	45.2	Mar. 28.
		Apr. 20	Apr. 26	38.5	Apr. 23.
		May 16	May 26	41.9	May 21.
Mount Vernon, Ind	35	Mar. 20	Apr. 7	46.1	Mar. 29.
		Apr. 19	Apr. 27	38.7	Apr. 23.
		May 16	May 29	43.4	May 23.
Dam No. 49	35	Mar. 21	Apr. 9	47.3	Mar. 31-Apr. 1.
		Apr. 20	Apr. 28	38.3	Apr. 24.
		May 16	May 30	45.2	May 24.
Shawneetown, Ill	35	Mar. 21	Apr. 11	49.9	Mar. 31-Apr. 1.
		Apr. 18	Apr. 29	40.0	Apr. 24-25.
		May 16	May 30	47.5	May 24.
Dam No. 50, Fords Ferry, Ky	32	Mar. 20	Apr. 30	50.7	Apr. 1.
		May 14	June 1	48.1	May 24.
Dam No. 51, Golconda, Ill	38	Mar. 24	Apr. 8	46.3	Mar. 31.
		May 18	May 29	43.6	May 24.
Paducah, Ky	43	Mar. 26	Apr. 8	47.3	Apr. 3.
		May 20	May 27	43.7	May 24.
Dam No. 52, Brookport, Ill	35	Mar. 22	Apr. 29	47.3	Apr. 3.
		May 14	June 2	44.0	May 24.
Dam No. 53, Grand Chain, Ill	38	Mar. 22	Apr. 30	50.4	Apr. 4.
		May 13	June 4	48.8	May 21-23.
Cairo, Ill	45	Mar. 26	Apr. 13	51.9	Apr. 4.
		Apr. 21	Apr. 24	45.2	Apr. 23.
		May 15	June 5	51.8	May 21-22.
White Basin					
Black:					
Leeper, Mo	11	Apr. 16	Apr. 16	17.6	Apr. 16.
		May 14	May 14	20.0	May 14.
Poplar Bluff, Mo	14	Apr. 16	Apr. 19	18.0	Apr. 17
		May 15	May 18	18.4	May 15.
Black Rock, Ark	14	Mar. 19	Mar. 21	16.0	Mar. 19
		Apr. 16	June 3	23.1	May 22.
White:					
Cotter, Ark	21	May 16	May 18	29.4	May 16.
Calico Rock, Ark	18	May 15	May 19	36.4	Do.
Batesville, Ark	23	...do...	May 20	36.4	May 17.
Newport, Ark	26	May 17	May 23	32.1	May 19.
Georgetown, Ark	21	Apr. 23	June 6	28.4	May 23.
De Valls Bluff, Ark	24	May 21	June 3	26.9	May 25.
Clarendon, Ark	30	May 24	June 2	31.0	May 28.
Arkansas Basin					
Neosho:					
Parsons, Kans	22	May 13	May 13	23.7	May 13.
Oswego, Kans	17	...do...	May 14	22.1	Do.
Fort Gibson, Okla	22	May 15	May 17	25.5	May 16.
North Canadian:					
Woodward, Okla	6	May 7	May 7	7.0	May 7.
Canton, Okla	6	May 8	May 8	6.4	May 8.
Petit John: Danville, Ark	20	Apr. 2	Apr. 2	20.0	Apr. 2.
		Apr. 22	Apr. 23	20.8	Apr. 22.
		Apr. 28	Apr. 28	20.2	Apr. 28.
		May 16	May 19	23.6	May 17.
Arkansas:					
Webbers Falls, Okla	23	May 15	May 18	26.4	May 16.
Fort Smith, Ark	22	...do...	May 19	27.7	May 17.
Ozark, Ark	22	May 17	...do...	23.7	May 18.
Dardanelle, Ark	22	May 16	May 20	25.1	Do.
Morrilton, Ark	20	...do...	May 21	23.9	May 19.
Pine Bluff, Ark	25	May 19	...do...	25.8	May 20.
Yancopin, Ark	29	Mar. 7	Mar. 13	30.4	Mar. 11-12.
		Apr. 1	June 17	39.4	May 31.
Red Basin					
Sulphur:					
Ringo Crossing, Tex	20	Feb. 28	Mar. 3	24.4	Mar. 1.
		Mar. 6	Mar. 10	25.2	Mar. 7.
		Mar. 31	Mar. 31	20.1	Mar. 31.
		Apr. 27	Apr. 27	21.8	Apr. 27.
		May 16	May 19	24.7	May 16.
		May 26	May 29	23.8	May 26.
Naples, Tex	22	Mar. 4	Mar. 16	25.8	Mar. 11.
		May 1	May 6	23.5	May 3-4.
		May 21	May 26	24.4	May 22.
		June 1	June 5	23.4	June 2-3.

Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates From—	To—	Crest Stage	Date
MISSISSIPPI SYSTEM—continued					
Lower Mississippi Basin					
	Feet			*Feet*	
St. Francis: Chaonia, Mo.	22	Apr. 16	Apr. 19	35.3	Apr. 17.
		May 3	May 3	24.7	May 3.
		May 12	May 18	38.0	May 15.
Fisk, Mo.	20	Apr. 16	Apr. 22	26.5	Apr. 17–18.
		May 2	May 10	23.5	May 4.
		May 12	May 21	26.9	May 15–16.
St. Francis, Ark.	18	Apr. 15	Apr. 28	25.0	Apr. 21.
		May 5	May 28	27.1	May 18.
Madison, Ark.	32	Apr. 15	Apr. 15	32.3	Apr. 15.
Tallahatchie: Swan Lake, Miss.	24	Dec. 16	June 9	33.4	Apr. 8.
Yazoo:					
Greenwood, Miss.	36	Mar. 29	Apr. 27	38.2	Apr. 14–17.
Yazoo City, Miss.	25	Feb. 8	June 18	31.2	May 6–7.
Ouachita: Arkadelphia, Ark.	12	May 16	May 16	12.0	May 16.
Black: Jonesville, La.	50	May 9	May 14	50.1	May 11–13.
Mississippi:					
New Madrid, Mo.	34	Mar. 26	Apr. 30	40.8	Apr. 6.
		May 15	June 5	40.7	May 22–24.
Memphis, Tenn.	35	Apr. 3	Apr. 20	39.0	Apr. 11.
		May 22	June 7	38.7	May 29.
Helena, Ark.	41	Mar. 31	May 7	50.5	Apr. 13.
		May 19	June 12	50.6	June 2–3.
Arkansas City, Ark.	42	Apr. 3	June 17	51.8	Apr. 17–19.
				53.6	June 4–6.
Greenville, Miss.	36	Apr. 5	June 19	44.7	Apr. 18–20.
				47.2	June 6–7.
Vicksburg, Miss.	45	Apr. 14	May 14	48.1	Apr. 22.
		May 27	June 18	48.8	June 10.
Natchez, Miss.	46	Apr. 17	May 19	49.6	May 2–3.
		May 26	June 21	50.4	June 12.
Angola, La.	45	Apr. 21	May 20	47.6	May 5.
		May 29	June 21	48.0	June 12–14.
Baton Rouge, La.	35	Apr. 20	June 23	38.0	May 4–5.
				38.5	June 15.
Donaldsonville, La.	28	Apr. 22	May 19	29.8	May 5.
		June 2	June 22	30.1	June 14.
Reserve, La.	22	Apr. 25	May 17	23.0	May 5.
		June 6	June 20	23.1	June 14–16.
New Orleans, La.	17	May 2	May 12	17.4	May 4.
		June 10	June 19	17.4	June 15–16.
Atchafalaya Basin					
Atchafalaya: Simmesport, La.	41	May 6	May 14	41.2	May 9–12.
		June 12	June 14	41.0	June 12–14.

Table of flood stages March to June, inclusive, 1933—Continued

River and stotion	Flood stage	Above flood stages—dates From—	To—	Crest Stage	Date
MISSISSIPPI SYSTEM—continued					
Atchafalaya Basin—Continued					
	Feet			*Feet*	
Atchafalaya—Continued					
Melville, La.	37	Apr. 25	May 21	38.3	May 6–11.
		May 31	June 21	38.4	June 13–14.
Atchafalaya, La.	22	Jan. 10	June 29	24.1	May 8–16.
					June 10–18.
WEST GULF OF MEXICO DRAINAGE					
Trinity:					
Dallas, Tex.	28	Mar. 6	Mar. 8	34.0	Mar. 7.
		Apr. 26	Apr. 26	28.7	Apr. 26.
		May 16	May 17	32.0	May 16.
		May 26	May 28	32.2	May 26.
Trinidad, Tex.	28	Mar. 10	Mar. 17	34.3	Mar. 14.
		Apr. 29	May 1	29.1	Apr. 30.
Liberty, Tex.	25	May 29	June 7	32.3	June 4.
		Mar. 8	Mar. 13	26.0	Mar. 10–11.
GULF OF CALIFORNIA DRAINAGE					
Eagle: Eagle, Colo.	5	June 1	June 2	5.5	June 2.
		June 4	June 8	6.0	June 7.
		June 10	June 18	6.8	June 12.
Roaring Fork: Carbondale, Colo.	5	May 31	June 7	6.1	June 2.
		June 10	June 21	6.4	June 12.
North Fork: Paonia, Colo.	9	May 31	May 31	9.2	May 31.
Gunnison: Delta, Colo.	9	May 27	June 7	10.5	June 2.
		June 12	June 13	9.2	June 12.
Colorado:					
Grand Junction, Colo.	11	June 3	June 3	11.5	June 3.
		June 13	June 13	11.0	June 13.
Parker, Ariz.	7	May 26	June 30	11.4	June 19, 20, 22, 23.
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
Kootanai: Bonners Ferry, Idaho	31	June 18	June 21	32.0	June 19.
Clark Fork: Newport, Wash.	22	June 15	June 29	24.8	June 21–23.
Clearwater: Kamiah, Idaho	12	May 30	June 19	16.6	June 10.
Santiam: Jefferson, Oreg.	10	June 9	June 9	12.0	June 9.
Willamette: Portland, Oreg.	24	June 11	June 22	24.8	June 13.
Columbia:					
Marcus, Wash.	24	May 14	(1)	38.7	June 22, 23.
The Dalles, Oreg.	40	June 18	June 20	40.5	June 19.
Vancouver, Wash.	15	May 28	(1)	25.5	June 19.

[1] Continued into July.

HISTORY OF THE APPLICATION OF METEOROLOGY TO AERONAUTICS WITH SPECIAL REFERENCE TO THE UNITED STATES[1]

By WILLIS RAY GREGG

INTRODUCTION

Aeronautics, as an industry, is less than 30 years old. Thus, it has come into being and developed to its present stature many years after the organization of national weather services. In this respect it is unique among the major industries.

Roughly speaking the world began to regard weather seriously about three quarters of a century ago. At that time agriculture, commerce, and marine navigation had been "going concerns" for centuries. True, in more recent years they have undergone marvelous development and change, but basically they were much the same then as now. It was necessary, therefore, that meteorological service be organized to meet the needs of these industries as they existed. With the changes in all lines of industry that have since occurred it has, of course been necessary for meteorological service to adapt itself to these changes. The same factor that has played a major role in revolutionizing industry, namely, the marvelous development in the speed of communications, is likewise largely responsible for the changes that have taken place in weather service. Speed in assembling the data and promptness in making them and the forecasts based on them available for use are the all-essential features in providing service to all classes of industry. Fortunately, when aeronautics appeared on the scene, demanding its share of service, the proper tools were at hand. It was only necessary to sharpen some of them, reshape others, and put them all to work.

MAN'S DESIRE TO FLY

Although aeronautics as an industry is not yet 30 years old, it is through no lack of desire on the part of man to fly that it was so late in arriving. From the earliest recorded times man has not only desired but in many cases has tried to fly. As early as the fourth century B.C., according to Aulus Gellius, a model was made of wood, in the form of a bird, and was to be flown by regulated mechanics. Thus, the first attempt of which we have a record was with a heavier-than-air device.

It is quite certain that an ascent was made in a hot-air balloon during the reign of the Emperor Nero, and perhaps the tragic ending of that flight marked the beginning of a much-too-long list of what we now call "aircraft accidents." That these were not merely isolated attempts of crack-brained enthusiasts is evident from a reading

[1] Read before the meeting of the American Meteorological Society, June 20, 1933, in connection with the Century of Progress Exposition, Chicago, Ill.

of one of the satires of Samostathenes, in which ridicule is heaped on those who had tried to devise various means for enabling men and ships to soar through the air, thus showing that the idea of flying already had many devotees. Occasional references to the subject are to be found also in the writings of Plautus, Juvenal, and many others of that period.

But, although there were many who worked on the problem, by far the greater number regarded the subject as one fit only for ridicule. Since man was not endowed with wings, it was not intended that he should fly, so they thought. And it was presumptuous for him to try to do so, and he should be punished for it! This view persisted for more than 20 centuries, and was prevalent down to a time within the memory of most of us. Witness the ridicule heaped on Langley—the only reward he received in his lifetime for all his splendid effort. As Wilbur Wright said in 1915: "By common consent men had adopted human flight as the standard of impossibility. When a man said: 'It can't be done—a man might as well try to fly', he was understood as expressing the final limit of impossibility."

Not but that man had been able to do *some* traveling in the upper air. In balloons he had done so innumerable times, but always subject to the vagaries of the winds. He had control only over his vertical movements. As to horizontal travel he was practically helpless. He could not go southward if a wind blew from that direction. Thus, 30 years ago, mankind generally was hopelessly skeptical as to the possibility of ever flying in heavier-than-air craft, and was firmly convinced that lighter-than-air navigation was merely a sport, having little to offer in the way of practical utility.

EARLY ASSOCIATION OF METEOROLOGY AND AERONAUTICS

Since aeronautics as an industry has developed wholly within the past few years, the application of meteorology to it would naturally seem to be limited to the same period. This is not strictly true, however, for the two have been more or less closely associated for nearly a century. Singularly enough the relationship was originally quite the opposite of that in recent years. Now, with some exceptions, it is meteorology that serves aeronautics. Formerly it was aeronautics that served meteorology. It was early seen that free balloons offered an opportunity for securing information not otherwise obtainable, and it is interesting to find that meteorological observations were made during balloon ascents by Dr. Jeffries, an American, as early as 1784 and by Benedict de Saussure in 1787. In the century that followed a large amount of data was collected in numerous ascents, among the most notable of which were the classic voyages of Glaisher, Flammarion, de Fonvielle, and Tissandier. Many of these reached great heights, including one in 1862 by Glaisher and Coxwell, which was estimated to have risen to 11,200 meters.

It is of particular interest to American meteorologists to find, in the "Report of the Chief Signal Officer for the Year 1872", the following paragraph:

> The experiment of a balloon ascension has been tried with fair results. The ascension was made by contract had with a professional aeronaut, and had in view the determination of the question whether the proper instruments could be carried and used with needful accuracy, an observer-sergeant being charged with the duty. One hundred and fifty-six readings were made during the ascension. This experiment is thought to have established that very delicate instruments may be employed hereafter, if it is considered advisable.

A very good prophecy to be abundantly fulfilled in later years.

THE METEOROLOGIST STUDIES THE UPPER AIR

Although the data accumulated in balloon ascents were extremely interesting, they yielded comparatively little of real value, owing to their fragmentary character and none too great accuracy. Moreover, this method was expensive and therefore fell in disfavor so far as its use in securing meteorological records is concerned.

The last quarter of the nineteenth century marks the beginning of really serious effort to secure systematic and accurate information concerning conditions in the upper air. It was during this period that several mountain observatories were established, including Pike's Peak, Colo., and Mount Washington, N.H., in this country. It was soon recognized, however, that, although the data were of great interest and value in certain studies, they were not truly representative of conditions in the free air. They were too much influenced by the mountain itself and by the neighboring terrain. In short, they represented neither true surface nor true free-air conditions.

It was during this period also that the study of clouds was begun in a scientific way. True, clouds had held a fascination for men since the dawn of history, and much had been written about them. Quite possibly one of these early observers, more keen than his fellows, noting the varying direction and speed of different layers of clouds, may have speculated as to the journey he would take, could he rise to their height and travel in the air currents that were speeding them along. In general, though, the literature of clouds prior to 1880 deals with their beauty, or associates their form and color with expected weather. There is little as to what they may reveal regarding the structure and characteristics of the atmosphere itself.

Following 1880, however, the systematic observation of clouds was taken up vigorously at the Blue Hill Observatory in this country; at Upsala, Sweden; and at Kew Observatory, England. The International Meteorological Committee considered the subject in 1885, largely through the interest of Hildebrandsson, and, at the meeting of the International Cloud Committee in 1894, besides the adoption of the nomenclature of clouds and instructions for observing them, it was decided to organize an international campaign of cloud observations. The plan was carried out from May 1, 1896, to May 1, 1897, in several European countries, at Toronto, Manila, and Batavia, and at Washington and Blue Hill in the United States. It is not too much to say that the data, which included the results of trigonometric observations, constituted a mine of information that yielded conclusions of far-reaching importance in our conception of the structure of the atmosphere.

Meanwhile other methods of upper-air study were being considered. In 1885 Prof. Cleveland Abbe, pioneer in many lines of meteorological research, urged the use of kites and, following the meeting of the International Conference on Aerial Navigation at Chicago in 1893, the project was rapidly developed. Notable series of records by this means were made in the United States by the Blue Hill Observatory under Rotch, Clayton, and Fergusson and by the Weather Bureau under Marvin, as well as in other countries, including particularly England, France, and Germany. In recent years kites have been largely abandoned in favor of the airplane which is more satisfactory in every respect. It is altogether likely that this method will be very extensively employed in the future.

The latter part of the nineteenth century saw also the advent of the sounding balloon. Both kites and airplanes have very decided limitations as to heights that they can reach. Only under exceptionally favorable conditions will kites go above 5 kilometers, and the average is much lower, about half this height. Airplanes have no difficulty in reaching 5 kilometers quite regularly, but going much above this is not practicable with existing types. Sounding balloons, on the other hand, have made possible the exploration of the upper atmosphere to heights of 20 to 30 kilometers. Their introduction marked an epoch of far-reaching importance in meteorology, since they led to the discovery of the stratosphere, the study of which, by Humphreys, Gold, and others, has led to a complete revision of our conception of the structure of the atmosphere. The first balloons were made of paper. Later, rubber balloons were employed and these are still in use at the present time. Among the names prominent in the pioneer stage of this type of investigation are those of Teisserenc de Bort, Richard Assmann, Hugo Hergesell, W. H. Dines, and A. Lawrence Rotch. The last named, as head of the Blue Hill Observatory, carried out several notable series of observations at St. Louis and over the tropical Atlantic.

In order to secure the greatest possible value from the observations there was organized an "International Commission for Scientific Aeronautics," later called "International Commission for the Exploration of the Upper Air", under whose general direction simultaneous ascents were made in many countries on designated "international days." For many years the data have been published in collected form and are thus available for synoptic as well as individual studies.

Data that are secured by means of kites, airplanes, and sounding balloons include pressure, temperature, and humidity. Observations of wind are also made with the kites and sounding balloons. Comparatively light instruments, called meteorographs, have been designed for recording these elements. Recently considerable work has been done in the development of radio-meteorographs, but these are still to a large extent in the experimental stage. It is of interest to note, however, that some good records have recently been secured at Fairbanks, Alaska. This method, if it is successfully developed and can be employed at reasonable cost, should prove a most valuable addition to those now in use, since by its use observations can be made in types of weather and in isolated regions in which all other methods fail.

One of these "other methods", and a most important one, is the use of so-called "pilot balloons." This method is comparatively inexpensive, but it yields information only regarding winds at various levels and the heights of clouds. Moreover, its use is limited to clear weather or to regions below clouds. Nevertheless, it has added greatly to our knowledge of the upper air. Its value will be vastly enhanced if it can be combined with radio, so that observations can be made in cloudy as well as in clear weather. Pilot balloons are undoubtedly used more extensively than any other method of free-air exploration. In the United States alone, including Alaska, Hawaii, and Puerto Rico, there are nearly 100 stations at which observations are made from two to four times each day.

Within the past 5 years, "ceiling" balloons have been added to the list of devices used in unraveling the secrets of the atmosphere. These are miniature pilot balloons—toy balloons in fact. They serve one purpose only, that of determining the height of clouds, or what is generally referred to as "ceiling." This use of the word is perhaps unfortunate, since ceiling also defines the maximum height which any given airplane can reach. However, both uses are now firmly established and in general there is little likelihood of confusion.

Ceiling balloons can be used efficiently only in determining the heights of relatively low clouds, chiefly those up to about 2,000 feet above the surface. They are of inestimable value in giving current information for fliers and are also providing an immense body of statistical data regarding the heights of lower clouds in different parts of the country, at different times of the day, in the various seasons of the year, and under varying conditions of pressure distribution. Similar data are obtained at night by means of ceiling lights.

It is an interesting fact that all of the earlier efforts to explore the upper air had as their chief aim not the application of meteorology to aeronautics but the increasing of our knowledge of the structure of the atmosphere. Some thought was given to the use of this added information in forecasting, but for the most part "aerology" was looked upon as "pure science" rather than as "applied science." It is quite natural that this should have been the case. Prior to the World War, aeronautics as an industry did not exist. There were stunt flights and trial flights with new designs. Due regard was of course paid to the weather prevailing at the time. But the pilot was his own observer. Forecasts rarely were requested except in the case of the National and International Free-Balloon Contests for which it was necessary to fix a definite date some time in advance. Many of the leading balloonists were themselves pretty fair meteorologists and in some cases a professional meteorologist was taken on the flight as aide and adviser. A beginning had been made also in Germany in connection with flights of the Zeppelin airships but, for the most part, there was little direct application of meteorology to aeronautics anywhere in the world.

Fortunately, however, the data that were being secured for purposes other than their usefulness to aeronautics were destined later to serve that activity in a very real and vital way. They provided a fund of information as to average conditions of air density and movement which were of great aid in connection with the design and construction of aircraft of all types. In a very real sense, therefore, meteorology may be said to have been ready for aeronautics when the latter called for its aid.

METEOROLOGY AND AERONAUTICS IN THE WORLD WAR

As the Great War provided the impetus for the rapid development of aeronautics itself, so naturally it heralded the advent of many assisting agencies. Meteorology, one of the chief of these, had much of value to offer in the way of statistical information, but it now became necessary to develop a more direct relationship—that of current service. Stumblingly at first, but more surely as experience pointed the way, each major power engaged in the war built up a service that was remarkably efficient, considering the short time in which it was done. The most important lesson learned was that aeronautics requires a much more intensive and detailed type of service than is needed for any other human activity. More observing stations and more frequent reports from those stations were necessary. Forecasts for 24 to 36 hours were of little value. They were therefore supplemented by forecasts for 1 or 2 to 5 or 6 hours, depending on the expected duration of any given operation. Naturally every possible effort was made by each side to prevent its reports and forecasts from reaching the enemy. This

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made all the more necessary the organization of a detailed and intensive service by each side in territory under its control.

The entry of the United States in the war marked the first official recognition by this country of the importance of meteorological service to aeronautics. In May 1917 Congress incorporated in the War Department bill an act entitled "For the establishment and maintenance by the Weather Bureau of additional aerological stations, for observing, measuring, and investigating atmospheric phenomena in the aid of aeronautics, including salaries, travel, and other expenses in the city of Washington and elsewhere, $100,000 to be expended under the direction of the Secretary of Agriculture." This appropriation was to be used in the United States proper and was therefore in addition to what was spent in meteorological service at the front. The latter was in general similar to that previously organized by other countries engaged in the war and was of course coordinated, so far as possible, with those of the countries with which the United States was associated.

The appropriation of $100,000 was used largely in establishing five additional aerological stations in this country, and in carrying out various projects in cooperation with the War and Navy Departments. Among these was a very thorough investigation of the use of pilot balloons, leading to the adoption of a formula for their rate of ascent for different weights, free lifts, etc. Many of the data, already accumulated by means of kites, sounding balloons, etc., were summarized and published for the information and use of the military branches of the Government. In every possible way meteorology endeavored to do its part in winning the war.

POST-WAR DAYS

Following the ending of hostilities there came a period of several years in which little progress was made. Aeronautics itself underwent a discouraging slump, particularly in this country. It was natural, therefore, that there should have been a slackening of effort in meteorological service. Fortunately, however, the special appropriation of $100,000 was continued each year, being transferred from the War Department direct to the Weather Bureau. The aerological program was therefore continued, even though no extension was possible. With the data thus secured several investigations were carried out, among the most important perhaps being that which led to the adoption of a "standard atmosphere." Other studies set forth the essential characteristics of the atmosphere and their relation to aeronautics.

That there was an increasing recognition and appreciation of the importance of weather service is evident in several ways. For example, early in 1919 the Navy Department staged the first successful crossing of the Atlantic by air. The preparations included an elaborate system of weather reports from the Atlantic, which were used as a basis for forecasts. Other trans-Atlantic attempts, long cross-country flights, and free-balloon contests all took full cognizance of the necessity for information concerning the weather.

An event of considerable significance was the inauguration by the Weather Bureau on December 1, 1918, of so-called "flying-weather forecasts", designed chiefly to assist the aerial operations of the War, Navy, and Post Office Departments. In the earlier years these forecasts were given for areas or zones. Later they were changed to cover specific routes or airways. This system was thus the forerunner of the present service of intensive, short-period route and trip forecasts.

Meanwhile the War and Navy departments had organized small meteorological units of their own, which, in cooperation with the Weather Bureau, provided special service for their particular needs. Observations obtained at the stations controlled by each of these organizations were made available to the others, both for current use and for statistical purposes, and thus duplication of effort and expense was avoided or at any rate kept to a minimum.

During this period of 6 or 7 years after the war, progress was rather more rapid in some of the European countries, where national subsidies made possible the laying out of civil airways and the establishment of meteorological service and other aids for scheduled flying. Generally speaking, though, there as here this whole period was one of transition and experiment. Aeronautics had demonstrated its utility in military operations. What had it to offer for peace-time pursuits? The public was skeptical. It had to be shown. A few stunt flights would not do this. What did? Undoubtedly, more than anything else in this country, the notable record made by the Air Mail was responsible for bringing aeronautics into its own. That record definitely showed that schedules can be set up and followed with a high percentage of regularity. When the public became aware of this fact, it was ready to take action accordingly.

METEOROLOGY AND CIVIL AERONAUTICS

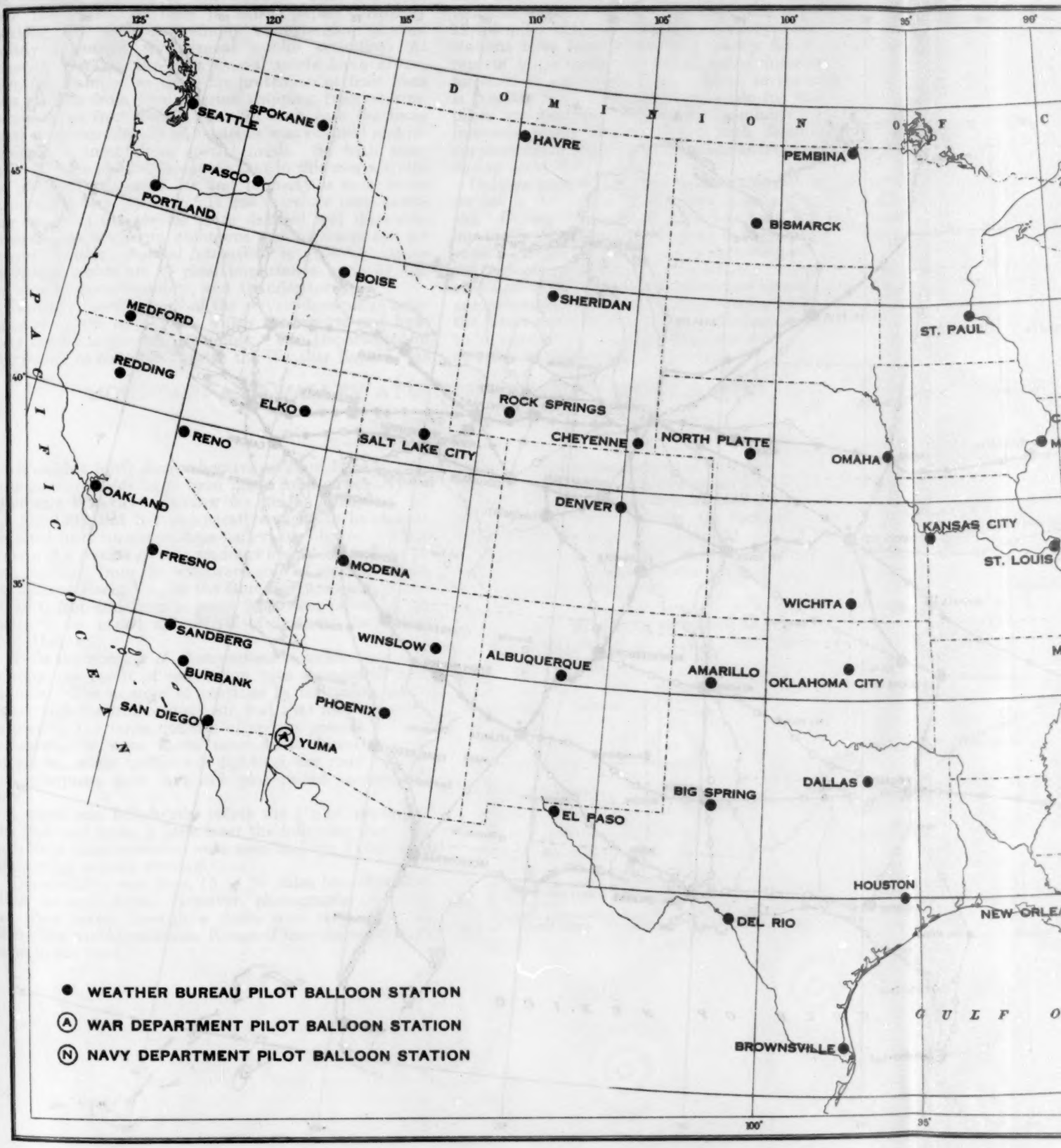
That action found expression in the Air Commerce Act, passed by Congress on May 20, 1926. Before the passage of this act there was no Federal regulation of civil aeronautics in this country. Instead there was regulation of various sorts in different States with hopeless confusion resulting. The Air Commerce Act provided the proper authority for changing this. Machinery was set up for issuance of regulations, licensing of pilots, classifying of airports, and inspection of aircraft. For this work the Aeronautics Branch was organized, under an additional assistant secretary, in the Department of Commerce.

An equally important part of Federal encouragement and support of aeronautics is the provision of navigational and other aids, such as emergency landing fields, beacon lights, prompt communication facilities, and adequate weather service for all flying activities on Federally established civil airways. Except for the weather service, responsibility for providing these aids was placed in the Bureau of Lighthouses, of the Department of Commerce, a new branch known as the Airways Division being created for this purpose.

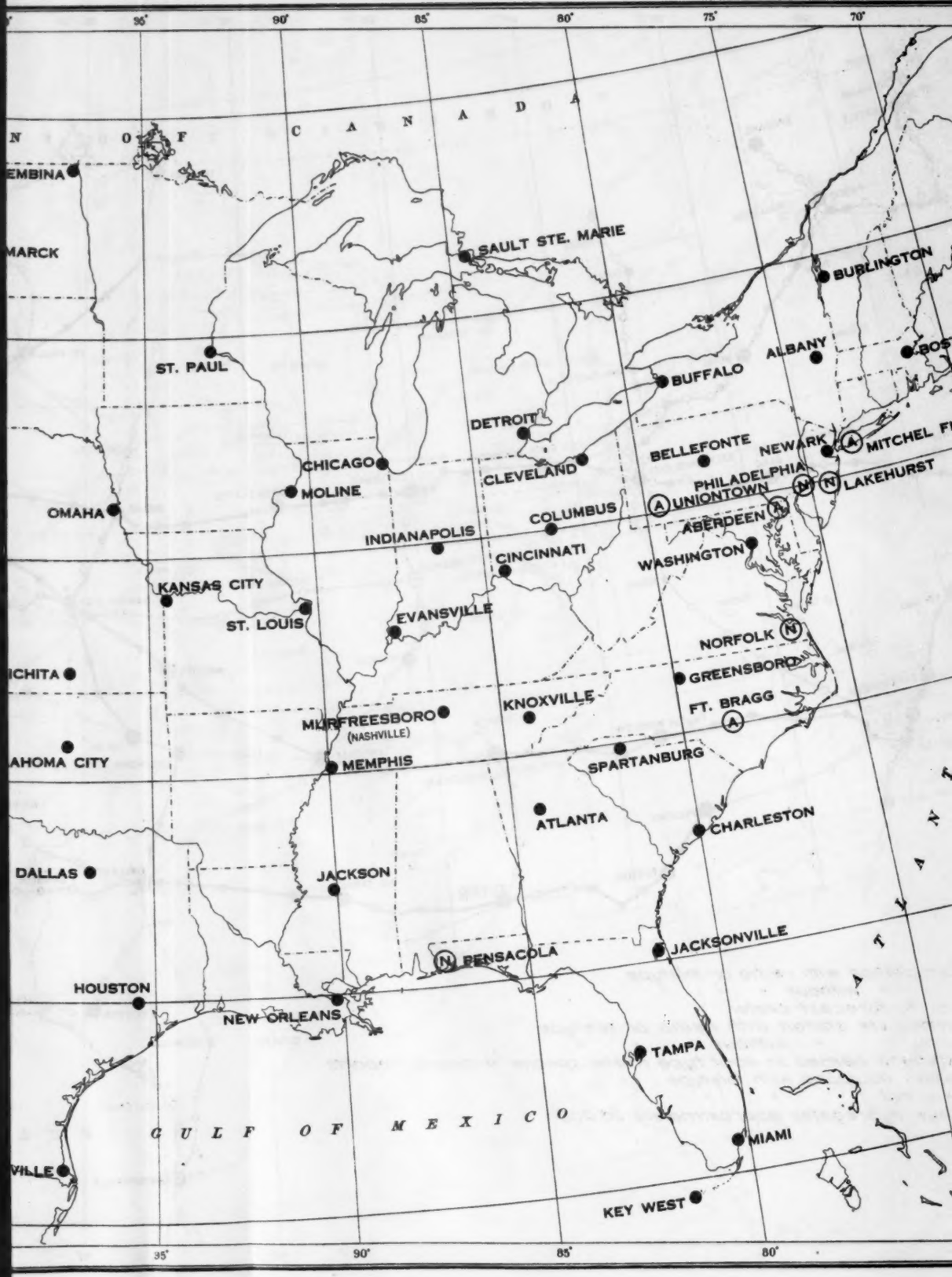
The work of organizing and maintaining an adequate weather service was naturally assigned to the Weather Bureau, whose already-existing elaborate system of reports and forecasts for general needs made necessary only an extension along similar lines, though in more detail, to meet the requirements of pilots. As authority for this service the Weather Bureau's organic act was amended to include specifically the furnishing of weather reports, forecasts, and warnings "to promote the safety and efficiency of air navigation in the United States and above the high seas, particularly upon civil airways designated by the Secretary of Commerce under authority of law as routes suitable for air commerce."

The present service for civil aeronautics in the United States, including Alaska and Hawaii, has been organized

Chart I. Pilot-balloon Stations, July 1, 19



lot-balloon Stations, July 1, 1933



65°
55°
LINGTON
BOSTON
40°
MITCHEL FIELD
KEHURST
A N T I C O C E A N
35°
30°
25°
75°

UNIV. OF

Chart II. Weather Bure

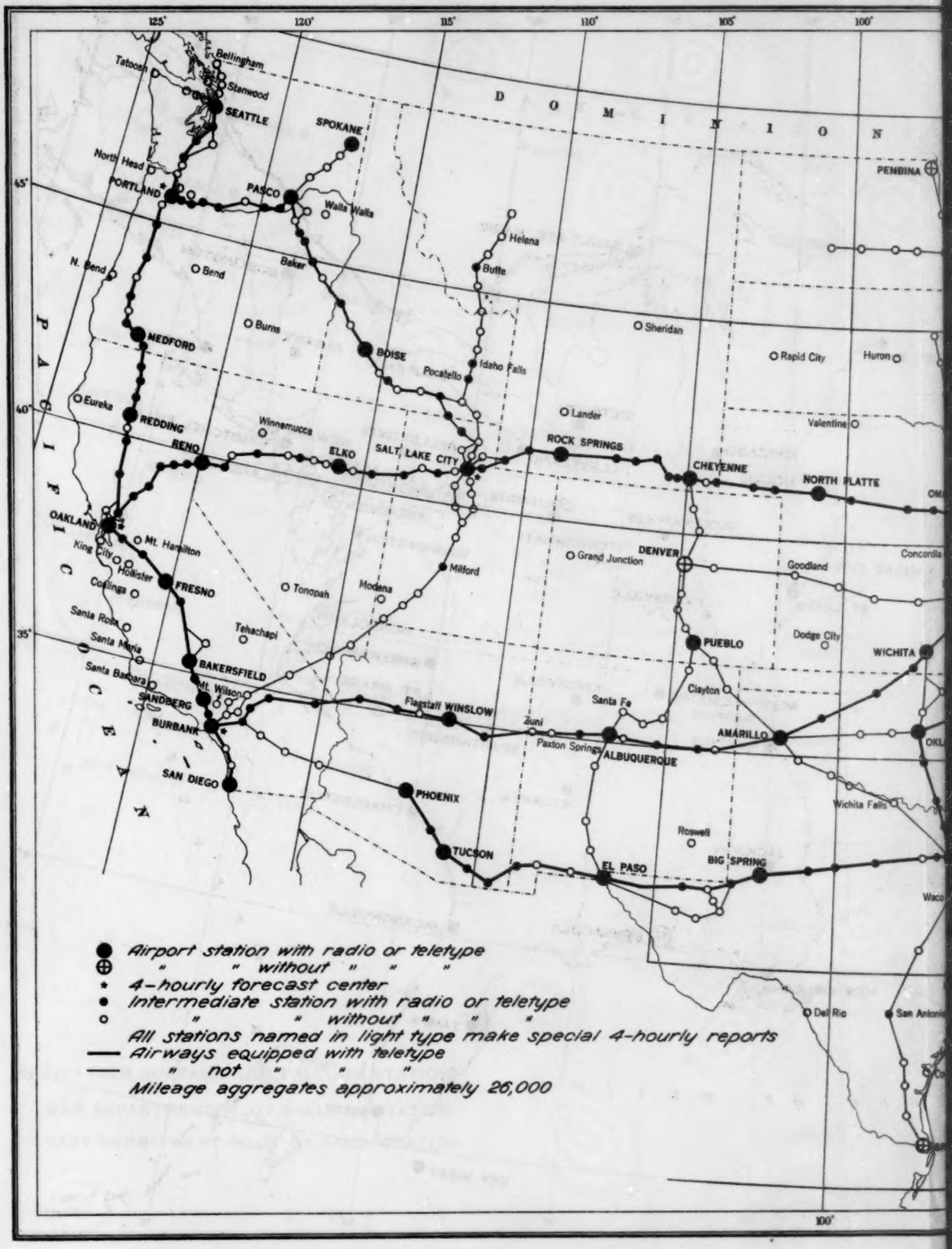


Chart II: Weather Bureau Airways Service, July 1, 1933

ly reports

and is now functioning under the authority contained in this act. It is not necessary here to discuss in detail the essential features of this service. That has been done from time to time in other papers. Broadly speaking, the service is simply an extension of that already organized for general public activities. At different times in the past special needs have arisen, such, for example, as those for protection of fruit from frost, forests from fires, marine shipping from storms, certain areas from floods, etc. In each case the basic weather service already in existence was adapted and intensified to meet those special needs. So with aeronautics. The chief difference is that in this new activity the factor of danger to life and property is more acute than in ordinary pursuits. It has therefore been necessary to make the service more detailed and intensive. Observations are more numerous and forecasts are for shorter periods. Special attention is given to those conditions which are of chief importance, such as fog, low clouds, poor visibility, and thunderstorms.

Naturally the efficiency of the service depends in large measure on the speed with which the reports and forecasts are made available to pilots. The Department of Commerce, in cooperation with the Weather Bureau, has organized a system of communications which meets the need very effectively. About 13,000 miles of airways now have continuous teletype service. At important terminal airports on these airways and also on about 12,000 miles which do not yet have teletype service, radio stations have been established, partly for exchange of reports but chiefly for broadcasting information and forecasts to aircraft in flight. Thus, to the extent that is possible with appropriations made for the purpose, pilots are provided with up-to-the-minute reports and forecasts based thereon *before* each flight and with supplementary reports and forecasts at frequent intervals *during* each flight.

Only an extreme optimist would claim that the present service is the ideal. The service is only about 5 years old. During that period there has been much experimentation, with changes resulting as suggested by experience. There is reason to believe that the basic and essential features are sound and will probably endure, but there are bound to be changes in details as new ideas and methods are proposed. We should, and undoubtedly shall, in the future as in the past, adopt such changes as are shown to be superior to present methods in making aeronautics as safe and efficient as possible.

MOUNTAIN AND VALLEY ATMOSPHERIC-DUST MEASUREMENTS

By IRVING F. HAND

[Weather Bureau, Washington, July 1933]

Although a fairly comprehensive series of atmospheric-dust measurements have been made from airplanes (see MONTHLY WEATHER REVIEW for March 1924, vol. 52, pp. 133–139), but few comparative readings have been obtained from mountain tops and valleys below. Table 1 gives the results of five readings obtained on June 25 and 26, 1933, from the windward side of Skyland Drive at Crescent Rock, Va., on the Blue Ridge, at an altitude of 3,500 feet and from a point 2,600 feet below in the valley to the east 1 mile WSW of Syria at the foot of Dark Hollow.

While the number of observations is small, they tend to show the result of convection with increase of solar altitude. The number of particles in the valley seems rather high for free country air, but that may be owing in part to the large number of spores present. These measurements were made near dense forest growth. Moreover, while traffic was light on the road nearby, the infrequent cars that did pass raised considerable dust.

A slight rain fell shortly before the 1 p.m. reading of the 25th and again a little later the following day. On both days thunderstorms were seen in Page Valley west of the ridge toward evening.

The visibility was from 15 to 20 miles from Crescent Rock on both days. However, photographs on infrared films taken through a dense and very dark red filter show the Appalachian Range of mountains 30 to 40 miles to the west.

Perhaps the larger number of dust particles than might be ordinarily expected in free mountain air may account to some extent for the typical blueness for which the three ranges—the Blue Ridge, the Massanutten, and the Appalachian Mountains—are noted.

All measurements were made with the Owens dust counter, a description of which will be found in the issue of the REVIEW above cited.

TABLE 1.—*Summary of atmospheric-dust measurements*

Date and time	Location	Height above sea level	Clouds	Wind	Number of dust particles per cubic centimeter
June 25:		*Feet*			
9:00 a.m.	Rose River	900	4 st. cu.	Lt. w.	729
10:00 a.m.	Crescent Rock	3,500	7 st. cu.	Lt. w.	277
1:00 p.m.	do	3,500	9 st. cu.	Moderate w.	519
June 26:					
9:00 a.m.	do.[1]	3,500	Fog below; few fr. cu. above.	Calm	183
Noon	Rose River [2]	900	10 st.	Lt. var.	485

[1] Crescent Rock is about 1 mile from the tip of Hawk's Bill Mountain, the highest peak in the National Park of Virginia. From this point a commanding view toward the west is obtained.

[2] Rose River is a mountain stream. Near the place where the readings were obtained are a few scattered homes. The nearest town is Syria with a population of less than 100.

REMARKABLY LOW HUMIDITIES ALOFT OVER SAN DIEGO, CALIF.

By DEAN BLAKE

[Weather Bureau Office, San Diego, Calif.]

Several remarkable aerographical observations of abnormally low relative humidities were made during the month of June, 1932, at the naval air station, North Island, San Diego, Calif.

As is generally known, there is an inversion of temperature during the warmer months of the year along the California coast, where records made during the last 10 years show that almost invariably the temperature decreases to some point usually found within the first 2,500 feet of elevation. Above this point there is an increase which averages about 13° F., but which may be as much as 25° F. or 30° F., and which usually culminates near the 3,800-foot level.

The unusual features of the observations made in June 1932, however, were not connected with the temperatures but with the relative humidities. On 7 days the aerograph recorded relative humidities under 4 percent, and on 3 days 0 percent, or absolute dryness, was shown. On the morning of June 22, the corrected trace sheet gave readings of 0 percent at all levels from 8,000 to 10,000 feet.

Low humidity readings are found as a rule in the inversion layer, but these are the lowest ever recorded either at the surface or in the upper air at this air station and to my knowledge establish a new record for any place.[1]

Care is always taken at the air station to check the aerograph before and after each flight, and we are assured that the instrument was carefully calibrated a short time before the observations. Further proof of the accuracy of the instruments is offered by the almost simultaneous observations made by the aircraft squadrons, Battle Force. Both temperature and humidity records corresponded closely to those made at the air station, and zero relative humidities were also found.

The accompanying table shows the temperature, relative humidity, wind direction and wind velocity for each 1,000-foot level for the four days, June 13, 15, 21, and 22. Wind data are for the soundings nearest the time of the aerographical flight.

[1] Zero humidity was recorded with carefully checked apparatus at Angora, Turkey, May 9, 1926, and Sept. 30, 1926. Met. Zeit., v. 47, pp. 74-75, 1930.—*Editor.*

Temperatures, relative humidities, and winds aloft for June 13, 15, 21, and 22, 1932

Levels (feet)	June 13			June 15			June 21			June 22		
	Temperature	Relative humidity	Wind	Temperature	Relative humidity	Wind	Temperature	Relative humidity	Wind	Temperature	Relative humidity	Wind
	°F.	Percent	M.p.h.	°F.	Percent	M.p.h.	°F.	Percent	M.p.h.	°F.	Percent	M.p.h.
Surface	66	74	WNW. 15	64	64	W. 10	65	70	W. 8	66	78	WNW. 9.
1,000	61	80	NW. 6	59	74	WSW. 6	61	84	NW. 7	63	87	NNW. 4.
2,000	58	87	NNW. 5	55	84	W. 3	72	22	NNW. 10	71	51	NNE. 6.
3,000	63	54	NW. 8	50	93	SW. 9	77	11	NNW. 7	80	16	NNW. 14.
4,000	68	24	NW. 7	54	60	WNW. 15	81	2	N. 6	78	13	NNW. 14.
5,000	69	14	NW. 7	58	26	WNW. 15	79	1	NE. 4	76	10	NW. 9.
6,000	68	9	NNW. 6	59	20	WNW. 14	74	1	ENE. 4	75	6	WNW. 9.
7,000	68	5	NNW. 5	55	19	WNW. 15	70	2	SE. 4	75	3	W. 12.
8,000	67	2	WNW. 7	53	14	WNW. 15	62	2	SSW. 6	73	0	W. 7.
9,000	64	1		51	8		61	3		68	0	
10,000	61	0	WSW. 15	49	4	W. 19	61	1	S. 8	63	0	W. 8.
11,000				47	2					57	0	
12,000			SSW. 16	45	0	W. 25			S. 11			W. 6.

Weather maps for the 4 days show the usual summer-pressure situation over the Southwest and the Pacific Ocean just west of southern California; namely, a semipermanent thermal low barometric area over the interior with extension of isobars into the great valleys of California on June 13, 21, and 22, and a weak development of the north Pacific high area over the ocean. Other than this, the maps show little else in common in the pressure distribution over the far West.

Temperatures and relative humidities aloft over Sunnyvale, Calif., for July 10, 27, 31, and Aug. 19, 1931

[Authority, U.S. Navy Aerographer]

AEROGRAPHIC FLIGHT OF JULY 10, 1931

[No time given]

Altitude (meters)	Temperature	Relative humidity	Altitude (meters)	Temperature	Relative humidity
	° C.	Percent		° C.	Percent
Surface	24.4	57	1,905	20.6	0
193	22.6	28	2,409	17.9	0
1,016	24.8	5	3,129	13.6	4

AEROGRAPHIC FLIGHT OF JULY 27, 1931

[At 11:30 a.m.]

Surface	21.8	59	1,951	26.8	0
305	16.8	71	2,875	22.0	0
630	24.8	34	3,454	18.8	0
1,361	28.3	1			

Temperatures and relative humidities aloft over Sunnyvale, Calif., for July 10, 27, 31, and Aug. 19, 1931—Continued

AEROGRAPHIC FLIGHT OF JULY 31, 1931

[At 11:05 a.m.]

Surface	20.0	66	1,575	21.2	18
503	14.4	77	1,910	19.0	11
1,204	23.0	12	3,261	14.2	0

AEROGRAPHIC FLIGHT OF AUG. 19, 1931

[At 9:58 a.m.]

Surface	21.7	62	1,920	20.6	4
356	17.1	76	2,885	11.5	0
1,057	24.1	13	3,241	8.5	0

On each of the days the morning hours at San Diego were characterized by the customary stratus layer which dissipated between 9 and 10 a.m. on June 13 and 15, and between 7 and 8 a.m. June 21 and 22. The 15th and 21st remained clear, but cirrus and altocumulus clouds, moving from the west, prevailed the rest of the 13th, and cirrostratus clouds, moving from the southeast, were observed after the stratus cleared on the 22d.

UPPER WINDS AT RENO, NEVADA

By ARLIE R. LOWERY

[Weather Bureau Office, Reno, Nev., June 29, 1933]

A tabulation of pilot-balloon observations at Reno, Nev., during the 3-year period, 1930–32, inclusive, reveals that 98 percent of the possible ascensions have been made for the twice-daily observations at 3 a.m. and 3 p.m., P.S.T. A 77 percent average was obtained at the 4,000-meter level or 2,654 meters above the surface. The 3-year record for the winter season (December, January, and February) shows that 92 percent of the possible observations have been made at 2,000 meters, while 62 percent have been made at 4,000 meters. For the summer season (June, July, and August) the average is 99 percent for 2,000 meters and 89 percent for 4,000 meters.

This rather high percentage has been obtained in spite of the fact that Reno is only 30 miles east of the higher ranges of the Sierra Nevada Mountains, a region noted for stormy periods from October to May. The location is on the leeward side of this mountain barrier during most of the stormy periods, because these storms are usually accompanied by a wind-flow over the mountains from the southwest quarter, and this location has a direct relation to the number of ascensions possible. The wind direction and velocity at the 3,000- and 4,000-meter levels are frequently obtained during stormy weather over the high Sierras, when the ceiling is reported as zero or nearly so at the Donner Summit station which is west-southwest of Reno. In Gregg's Aeronautical Meteorology, page 196, the following statement occurs: "Ceilings are always higher over valleys and lower in the mountains when cyclonic conditions produce cloudiness." This condition is very noticeable in this locality. Not only does the ceiling form a sort of an arch over the valley, especially with a southwesterly wind-flow over the mountains, but large breaks in the cloud canopy over the valley are common. Under such conditions the cloud base to the east usually is higher than to the west, yet it may top the lower ranges east or even obscure them during the more stormy periods. A more nearly level cloud base occurs with a northerly, northeasterly, or easterly wind-flow over the mountains.

On account of the location of Reno the wind direction as recorded from the pilot-balloon observations at the lower levels in the valley (usually below 3,000 meters sea level) often varies considerably from that of the flow over the mountains. In an article in the MONTHLY WEATHER REVIEW, October 1931, volume 59, page 380, Delbert M. Little states: "The return flow near the surface on the leeward side of a mountain barrier has often been noted." This condition is very noticeable at Reno, especially when a southwesterly gale occurs at 3,000 or 4,000 meters. At such a time a northeasterly or easterly wind, occasionally moderate or even fresh, frequently is observed at the surface.

The table showing the percentages of times and average meters per second for the 16 points of the compass and for the surface (1,346), 2,000-, 3,000-, and 4,000-meter levels is taken from the 3 a.m. and p.m., P.S.T. observations for the 3-year period, 1930–32, inclusive. The wind roses are made directly from the data given in this table for seasonal winds. Beginning February 11, 1931, four ascensions have been made daily whenever possible. A table for the 2-year period March 1, 1931–March 1, 1933, shows the average velocity of all directions for each of the four times daily. This is computed for the surface and for the 3,000-meter level. According to this table, the surface winds are consistently highest at 3 p.m., P.S.T., throughout the year, and usually are lowest at 3 a.m. For the 3,000-meter level, the opposite is indicated, with the lowest velocity at 3 p.m. for all months except January. This agrees with observations made over the eastern and central portions of the United States. (Gregg's Aeronautical Meterorology, pp. 90–91.)

Another table shows the percentage of times and average meters per second from each of the 16 points of the compass for the three summer months of 1931 and 1932 at 3 a.m., P.S.T. The table also includes similar data for the same period, when thunderstorms followed within 24 hours. For the levels considered, there seems to be no appreciable difference between the wind direction at 3 a.m. on the days when thunderstorms followed within 24 hours, and the wind direction at this time for all of the days of the two summer seasons. However, there is a difference in the velocity. Although the average velocity of the wind on the surface at 3 a.m. for the two summer seasons is the same as that for the observations preceding thunderstorms, the average velocity preceding thunderstorms gradually falls behind the average velocity for the period as the altitude increases up to 4,000 meters. The average for the 4,000-meter level is 7.2 m.p.s. as compared with 5.2 m.p.s. preceding thunderstorms.

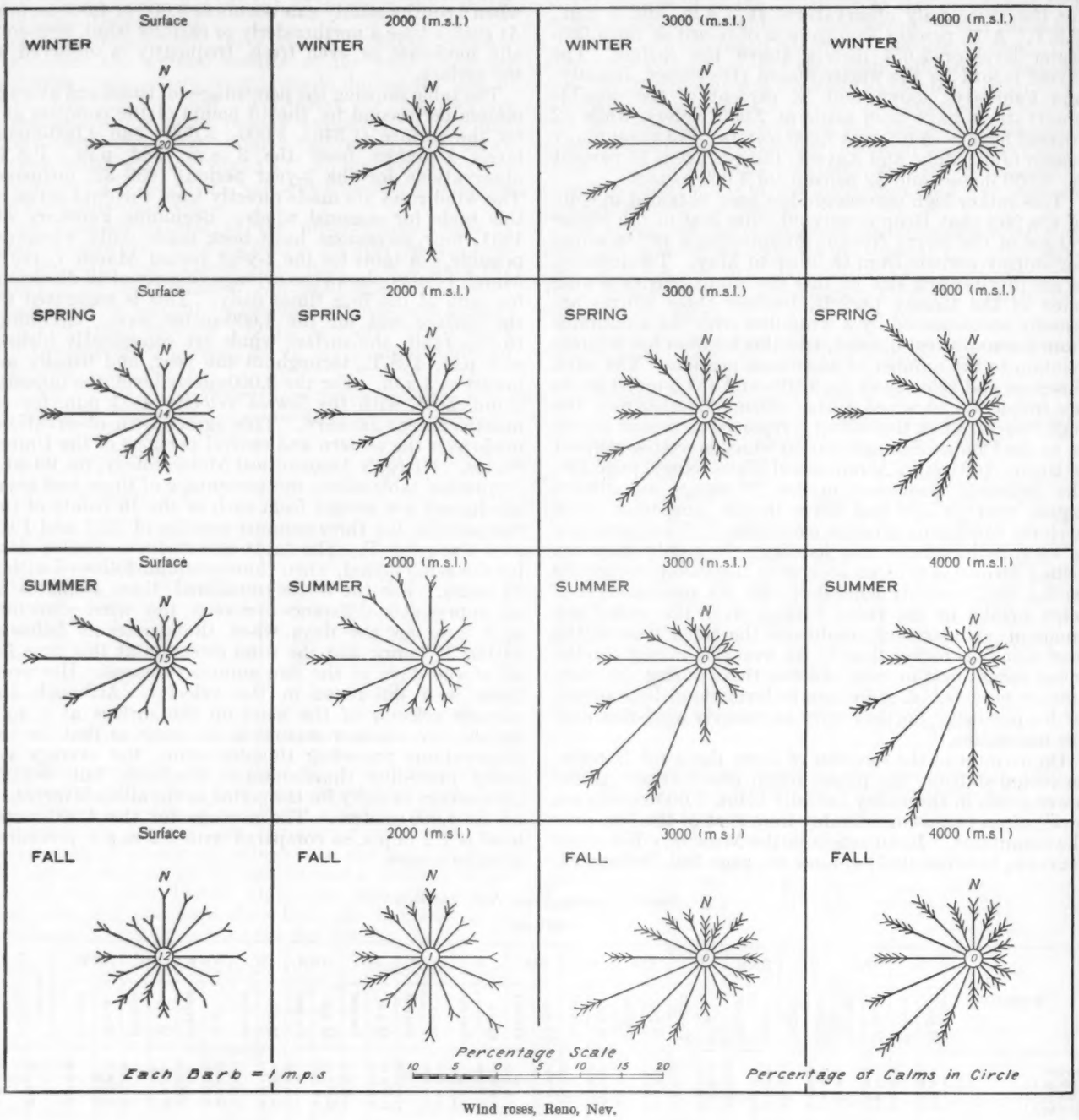
Seasonal winds, Reno, Nev., 1930–32

WINTER

Altitude	N.		NNE.		NE.		ENE.		E.		ESE		SE.		SSE.		S.		SSW.		SW.		WSW.		W.		WNW.		NW.		NNW.		Percent of calms	Percent of possible observations
	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent		
Surface	1.8	5	1.8	5	1.8	3	2.0	4	2.0	7	1.6	3	1.8	6	3.0	5	3.2	6	62.3	5	1.6	6	2.2	5	4.7	7	2.5	5	2.2	4	2.1	4	20	98
2,000 m.s.l.	4.0	3	2.8	4	2.2	3	2.2	2	1.9	5	2.7	6	3.1	11	3.3	11	4.3	12	5.1	7	4.5	6	6.6	9	6.7	7	3.6	6	2.9	3	4.9	4	1	92
3,000 m.s.l.	8.4	5	5.0	3	6.7	5	4.2	3	5.5	4	5.3	5	4.2	3	3.6	4	3.3	3	4.7	4	10.9	12	10.5	14	9.8	12	8.2	10	8.8	8	9.1	5	0	81
4,000 m.s.l.	10.0	9	12.3	5	5.0	4	4.0	2	1.7	2	4.0	2	2.1	3	3.5	2	3.6	4	4.0	2	12.9	7	12.0	10	12.0	13	12.6	14	12.2	12	12.3	9	0	62

SPRING

Surface	1.7	4	2.5	6	2.4	5	1.9	3	2.3	4	1.9	3	1.3	3	2.5	3	5.5	5	4.3	4	3.5	5	4.1	7	5.7	13	5.5	8	3.5	6	3.5	7	14	99
2,000 m.s.l.	5.1	6	3.5	5	1.9	4	1.4	3	2.5	3	2.9	4	3.7	8	2.4	4	3.3	5	4.7	7	5.7	8	6.0	8	6.8	12	5.6	9	4.2	6	3.7	7	1	98
3,000 m.s.l.	6.8	5	3.6	4	4.7	4	4.1	2	3.2	1	2.8	3	4.2	3	4.6	4	7.2	6	7.4	11	7.1	13	7.7	12	8.1	9	6.4	9	7.5	8	5.9	6	0	90
4,000 m.s.l.	7.7	5	7.6	4	2.0	2	6.3	2	0.1	1	3.5	1	2.9	2	3.2	2	8.0	6	8.9	9	10.6	11	8.3	10	10.3	15	10.5	9	11.2	13	9.1	8	0	74



Wind roses, Reno, Nev.

Seasonal winds, Reno, Nev., 1930–32—Continued

SUMMER

Altitude	N.		NNE.		NE.		ENE.		E.		ESE.		SE.		SSE.		S.		SSW.		SW.		WSW.		W.		WNW.		NW.		NNW.		Percent of calms	Percent of possible observations
	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent		
Surface	2.3	3	1.7	3	1.9	6	1.8	2	1.2	2	0.9	2	2.3	3	1.2	3	1.9	6	2.7	5	3.5	8	3.6	11	5.3	15	5.0	10	3.1	4	2.7	2	15	100
2,000 m.s.l.	3.1	8	2.7	3	1.9	5	2.8	3	2.5	3	1.8	2	2.7	3	2.6	4	3.3	4	4.5	5	4.1	7	5.3	11	7.0	13	4.9	10	3.8	9	3.1	2	1	99
3,000 m.s.l.	4.0	2	1.6	1	3.4	2	3.4	2	2.8	2	3.8	3	3.9	4	4.5	4	5.2	8	7.4	16	6.3	19	6.4	13	5.1	11	4.6	6	4.2	4	4.1	3	0	98
4,000 m.s.l.	3.2	1	0.7	1	1.3	1	4.3	3	3.9	2	4.2	1	4.4	3	6.3	5	9.7	13	8.9	19	8.7	15	8.1	14	7.8	9	6.7	8	4.1	3	2.4	2	0	89

FALL

Surface	2.5	6	1.9	6	2.1	6	2.1	7	2.1	8	2.1	5	1.2	6	1.7	4	3.5	5	4.6	4	4.0	6	2.9	5	3.5	6	3.0	7	2.9	4	2.4	3	12	99
2,000 m.s.l.	3.6	6	4.1	5	2.4	4	3.3	4	2.4	6	3.0	7	3.3	10	2.9	6	3.2	8	4.3	5	2.9	6	7.8	7	5.7	7	4.4	7	4.9	6	3.9	3	1	97
3,000 m.s.l.	6.6	3	6.3	3	6.4	5	7.2	5	6.6	5	6.7	5	3.9	4	4.4	4	5.1	5	6.0	9	6.9	11	8.4	15	7.8	10	8.2	7	5.5	5	4.3	4	0	94
4,000 m.s.l.	4.8	5	7.7	5	7.7	4	4.9	3	3.7	2	6.2	3	3.6	3	5.2	3	6.6	4	9.7	9	8.5	14	7.4	12	10.0	10	9.5	10	7.5	8	9.4	5	0	82

Avrage wind directions and velocities at 3:00 a.m., summer months, 1931–32, (a) all winds, (b) winds followed within 24 hours by thunder storms

	Surface 1,346 m.s.l.				2,000 m.s.l.				3,000 m.s.l.				4,000 m.s.l.			
	(a) Summer months		(b) Preceding thunder storms		(a) Summer months		(b) Preceding thunder storms		(a) Summer months		(b) Preceding thunder storms		(a) Summer months		(b) Preceding thunder storms	
	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.	Percent	M.p.s.
N	2	2.2			12	2.5	14	2.7	2	6.5	9	5.0	2	7.7		
NNE	1	2.5			4	2.7			2	6.0	5	9.0	1	2.0	4	4.0
NE	3	1.6	4	1.0	5	1.9			3	3.8	4	4.0	1	4.0	4	4.0
ENE	1	1.0			3	3.2	4	4.0	2	4.8	5	3.0	3	3.2	5	2.0
E	2	1.0			3	2.2			5	4.1	9	6.5	2	9.7	9	10.5
ESE	1	1.5			1	4.0	5	5.0	5	5.2	5	7.0	2	9.5		
SE	2	1.5			6	3.2	9	3.0	6	4.3	18	3.5	3	4.3	9	4.5
SSE	6	1.3	14	1.3	7	2.8	5	1.0	5	5.4	5	3.0	11	8.1	9	4.5
S	11	1.3	9	1.0	4	3.9	5	3.0	9	6.4	14	1.0	13	9.0	9	6.0
SSW	6	1.3	14	1.3	4	4.6	4	2.0	15	7.8	5	4.0	23	9.1	23	4.4
SW	8	1.4	9	2.5	2	3.2	4	1.0	22	7.2	4	5.0	15	10.0	9	7.5
WSW	4	1.8	5	2.0	2	2.5			12	7.6			9	7.4	5	4.0
W	5	1.4	4	3.0	3	4.6	4	4.0	5	5.8	4	3.0	6	8.5	5	6.0
WNW	4	2.5			9	4.3	5	5.0	3	6.2	9	3.5	6	8.3	9	4.5
NW	1	2.0			14	4.2	18	4.5	2	4.7	4	3.5	1	9.5		
NNW	1	2.5			18	3.9	2.3	4.6	2	4.8			2	5.3		
Calms	42		41		3		0		0		0		0		0	
Average m.p.s.		1.7		1.7		3.4		3.3		5.7		4.4		7.2		5.2

Average wind velocities for all directions, March 1, 1931, to March 1, 1933

	Velocities in m.p.s.							
	Surface 1,346 m.s.l.				3,000 m.s.l.			
	3:00 a.	9:00 a.	3:00 p.	9:00 p.	3:00 a.	9:00 a.	3:00 p.	9:00 p.
January	1.4	1.6	3.2	2.5	11.8	12.6	12.4	11.2
February	1.4	1.4	2.6	1.9	10.9	10.4	9.8	11.0
March	1.3	1.2	4.3	2.6	9.2	9.0	7.2	8.2
April	1.2	1.4	4.8	2.8	8.2	8.2	6.8	7.6
May	1.4	2.0	4.6	2.5	6.2	6.0	5.4	6.5
June	.9	1.6	4.8	3.9	5.9	6.3	5.2	6.1
July	.8	1.4	4.8	2.8	6.8	6.4	6.0	6.4
August	.8	1.2	4.8	2.2	6.2	6.3	4.6	6.1
September	1.0	1.2	3.4	2.1	5.8	5.4	4.6	5.6
October	1.2	1.2	3.4	1.8	8.0	7.6	5.9	6.4
November	1.4	1.2	2.9	1.6	9.9	9.4	9.0	9.8
December	1.5	1.3	2.3	2.2	9.4	9.3	9.2	11.2
Year	1.2	1.4	3.8	2.4	8.2	8.1	7.2	8.0

Average increase in velocity between surface and 3,000 m.s.l.

	3:00 a.	3:00 a.	3:00 p.	9:00 p.
Winter	9.3	9.4	7.8	8.9
Spring	6.6	6.2	1.9	4.8
Summer	5.5	4.9	.5	3.2
Fall	6.7	6.3	3.3	5.5
Year	7.0	6.7	3.4	5.6

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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING JUNE 1933

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1932, REVIEW, page 26.

Beginning with June 1933 values of the total solar radiation (direct + diffuse) as received at Riverside, Calif. (altitude 1,070 feet above sea level, latitude 33° 58′ north, longitude 117° 20′ west) will be included in table 2 through the courtesy and cooperation of Dr. E. R. Parker of the College of Agriculture, University of California.

Table 1 shows that solar radiation intensities averaged above normal for the three Weather Bureau stations at which normal incidence measurements are made. Observations have not been taken long enough at the Blue Hill Observatory to derive normals.

Table 2 shows a decided excess in the total solar and sky radiation received on a horizontal surface at all stations except Twin Falls, La Jolla, and Gainesville.

Table 3 shows low values of turbidity on the 14th only, with the exception of the very early morning readings of the 15th.

Polarization observations obtained at Washington on 4 days give a mean of 46 percent with a maximum of 52 percent on the 14th. At Madison, observations taken on 9 days give a mean of 60 percent with a maximum of 71 percent on the 13th. The values for Washington are below normal for June, while those at Madison are somewhat above normal.

TABLE 1.—*Solar-radiation intensities during June 1933*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D.C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A.M.					P.M.				
	e.	5.0	4.0	3.0	2.0	1.0[1]	2.0	3.0	4.0	5.0	e.
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
June 2	5.16			1.10	1.21	1.49	1.20				4.37
June 7	17.37	0.35	0.48	.61	.80						18.59
June 9	22.76		.54								22.00
June 12	16.79			.67	.84						15.11
June 14	6.27		.88	1.04	1.25	ff					5.16
June 15	6.27	.72	.82	.98	1.12						5.79
June 21	14.60		.40	.60	.75	1.20					17.96
June 23	10.97				1.00						10.21
June 24	13.13					1.19					10.21
Means		(.54)	.62	.83	1.00	1.29	(1.20)				
Departures		−.04	−.04	+.05	+.06	+.05	+.26				

[1] Extrapolated.

TABLE 1.—*Solar-radiation intensities during June 1933*—Continued

MADISON, WIS.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A.M.					P.M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	1.0[1]	2.0	3.0	4.0	5.0	e.
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
June 1	9.83			0.94	1.12	1.34					10.59
June 2	11.81				1.14	1.33					11.81
June 3	13.13					1.20					14.10
June 6	16.79				.90	1.19					19.89
June 7	16.79					1.37					17.96
June 9	11.81			.93	1.08						11.38
June 10	12.24				1.00	1.30					15.65
June 13	6.27				1.26	1.50					5.16
June 14	4.95			1.13	1.26	1.48	1.23				5.16
June 17	13.61				.98						15.11
June 19	12.24			.89	1.09	1.33	1.04				10.59
June 20	10.59			.89	1.09	1.30	1.10	.93			12.68
June 22	13.13			.95		1.42					9.83
Means				.96	1.09	1.34	1.12	(.93)			
Departures				+.01	+.08	+.02	+.03	+.01			

LINCOLN, NEBR.

June 1	12.24					1.32	1.00	0.79			9.47
June 3	13.13					1.37	1.08	.83	0.67		14.60
June 10	15.11		0.88	1.02	1.18	1.36					11.81
June 13	6.27						1.17	.97	.83	0.69	4.95
June 15	6.50			.96	1.17	1.32					7.04

TABLE 1.—*Solar-radiation intensities during June 1933*—Continued

LINCOLN, NEBR.—Continued

Date	Sun's zenith distance: 8a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A.M.					P.M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e.
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
June 16	8.18			1.03	1.21	1.43	1.16	.98	.82	.68	7.04
June 17	7.04		.90	1.03	1.21	1.42					7.29
June 19	10.59		.71	.82	1.04	1.25					10.97
June 22	10.97			.91	1.09	1.34					13.61
June 28	15.65			.94	1.12	1.35					17.96
Means			.83	.96	1.15	1.35	1.10	.89	.77	(.68)	
Departures			+.06	+.03	+.05	±.00	±.00	−.01	−.02	+.04	

BLUE HILL, MASS.

June 2	6.3			1.12		1.47	1.20				7.7
June 3	9.5			.96	1.12	1.50	.99	0.77			11.2
June 6	13.1						.71				11.2
June 9	14.1			.78	.96	1.28					16.8
June 11	13.1				1.03	1.37	1.12	1.00	0.87	0.70	14.8
June 14	7.3				1.09	1.31					7.1
June 15	6.5			1.03	1.17						6.5
June 18	8.2			1.00		1.45	1.20	1.06	.95	.91	7.7
June 23	8.2			1.00		1.45	1.20	1.06	.95	.91	7.7
June 24	10.6			1.04	1.17						10.9
June 28	16.8							.80	.67	.57	19.1
Means				.99	1.10	1.40	1.04	.91	.83	.73	

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Gainesville	Miami	New Orleans	Riverside
	Gram calories per square centimeter													
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
June 4	592	607	643	582	601	629	535	496	529	369	516	625	534	513
June 11	556	614	748	480	593	748	459	391	586	326	454	481	600	687
June 18	697	569	581	625	559	760	587	622	652	438	394	455	441	691
June 25	482	460	576	422	428	718	427	441	559	428	496	635	468	667
	Departures from weekly normals													
June 4	+94	+94	+95	+152	+178	−35	+54		−65	−44	+8	+101		
June 11	+63	+109	+210	+48	+57	+64	−29		−49	−82	−10	−27		
June 18	+206	+45	+17	+185	+197	+56	+93		−28	−26	−46	−66		
June 25	−44	−76	−24	−21	−8	+19	−51		−105	−69	+28	+73		
	Accumulated departures on July 1													
	+6,083	−3,983	+1,680	+6,321	+6,538	+4,431	+1,134		−28	−6,288	−9,716	−1,897		

TABLE 3.—*Solar-radiation measurements, and determinations of atmospheric turbidity factor, β, Washington, D.C., June 1933*

[Values in italics have been interpolated]

Date and solar-hour angle	Solar altitude, h.	Air mass, m.	I_m	I_s	I_r	β	Blueness of sky	Atmospheric dust particles per cubic centimeter	Notes: (sky-light polarization, P.) clouds, etc.
June 7			*gr. cal.*	*gr. cal.*	*gr. cal.*				
5:07a	24–02	2.45	0.673	*0.551*	0.442	0.190		766	
4:57a	25–58	2.28	.748	.508	.447	.145	5		P=36.8%
4:08a	25–26	1.71	.859	.642	.571	.195			
4:01a	36–44	1.67	.885	.647	.532	.195			
3:18a	45–12	1.41	.968	.717	.570	.195			
3:12a	45–56	1.39	.991	.718	.576	.190			
June 14									
5:59a	14–30	3.94	.916	.709	.597	.065		296	
5:55a	15–14	3.77	.942	.714	.600	.060			
5:33a	19–23	2.99	1.038	.776	.636	.060			
5:27a	20–30	2.84	1.047	.779	.641	.060			
5:15a	22–50	2.57	1.153	.830	.658	.045			
5:09a	23–56	2.46	1.170	.835	.662	.045			
4:50a	27–34	2.15	1.162	.879	.679	.070			
4:44a	28–42	2.08	1.213	.883	.684	.060	6		P=52.0%
June 15									
5:56a	15–07	3.79	.853	.703	.505	.050		548	
5:52a	15–52	3.63	.910	.708	.508	.038			
5:29a	20–22	2.85	1.006	.776	.634	.080			
5:25a	20–58	2.78	1.019	.779	.636	.080			
5:21a	21–43	2.69	1.031	.803	.649	.085			
5:16a	22–39	2.59	1.031	.808	.652	.090			
4:54a	26–52	2.20	1.093	.854	.676	.160			
4:48a	28–02	2.12	1.119	.856	.677	.170			
4:44a	28–43	2.07	1.125	.846	.685	.175			
4:39a	29–43	2.01	1.125	.849	.688	.180	5		P=46.0%

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent United States Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Perkins, and Mount Wilson observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1933	h m	°	°	°			
June 1 (Perkins Observatory)	11 40	No spots					
June 2 (Naval Observatory)	11 10	−71.0	150.7	−7.0	6		6
June 3 (Naval Observatory)	10 28	−57.0	151.9	−7.0	6		6
June 4 (Naval Observatory)	14 7	−42.0	151.7	−7.0	6		6
June 5 (Naval Observatory)	13 24	−30.0	150.8	−7.0	6		6
June 6 (Naval Observatory)	10 32	−17.0	152.2	−7.0	3		3
June 7 (Naval Observatory)	10 41	No spots					
June 8 (Naval Observatory)	11 2	No spots					

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1933	h m	°	°	°			
June 9 (Naval Observatory)	10 26	No spots					
June 10 (Mount Wilson)	9 5	No spots					
June 11 (Naval Observatory)	11 50	No spots					
June 12 (Naval Observatory)	14 38	−55.0	32.5	+4.0		37	37
June 13 (Naval Observatory)	11 2	−43.0	33.2	+4.0		77	77
June 14 (Mount Wilson)	8 20	−29.0	35.4	+4.0		92	92
June 15 (Naval Observatory)	11 8	−14.0	35.7	+4.0		129	129
June 16 (Mount Wilson)	9 30	−1.0	36.4	+5.5		112	112
June 17 (Naval Observatory)	10 32	+13.0	36.6	+5.0	56		56
June 18 (Naval Observatory)	12 38	+27.0	36.2	+5.0	43		43
June 19 (Naval Observatory)	11 9	+40.0	36.7	+5.0	46		46
June 20 (Naval Observatory)	11 7	+53.0	36.5	+6.0	46		46
June 21 (Naval Observatory)	13 10	+67.0	36.2	+6.0	53		53
June 22 (Naval Observatory)	13 58	+81.0	36.5	+6.0	53		53
June 23 (Naval Observatory)	11 50	No spots					
June 24 (Naval Observatory)	10 33	No spots					
June 25 (Mount Wilson)	10 0	No spots					
June 26 (Perkins Observatory)	15 0	No spots					
June 27 (Naval Observatory)	14 20	No spots					
June 28 (Naval Observatory)	10 44	No spots					
June 29 (Perkins Observatory)	14 15	No spots					
June 30 (Perkins Observatory)	12 45	No spots					
Mean daily area for June							26

The Perkins Observatory report for May, received too late for inclusion in the last issue, indicates that there were no spots on May 4, 8, 10, 11, 25, and 30. The mean daily area for May should therefore be changed to 12.

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR JUNE 1933

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen-Sternwarte, Zurich, Switzerland]

June 1933	Relative numbers	June 1933	Relative numbers	June 1933	Relative numbers
1	0	11	0	21	8
2	7	12	0	22	
3	7	13	*Ec* 12	23	0
4	7	14	16	24	0
5	7	15	19	25	0
6	14	16	14	26	0
7	0	17	10	27	0
8	0	18	8	28	0
9	0	19	8	29	0
10	0	20	8	30	0

Mean: 29 days=5.0.

c=New formation of a center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central zone.

AEROLOGICAL OBSERVATIONS

[Aerological Division, W. R. Gregg, in charge]

By L. T. SAMUELS

Free-air temperatures during June were mostly above normal with the largest departures occurring at Chicago and Omaha. (See table 1.) Free-air relative humidities averaged below normal at practically all stations and levels.

At 1,000 meters above sea level the resultant wind directions over the country east of the Rockies were in general close to normal and the resultant velocities above normal over the northern stations and below normal over the southern stations. (See table 2.) At 4,000 meters the resultant winds were more southerly than normal at several far western and southern stations. Resultant velocities were mostly above normal over the northern sections of the country and below normal over the South.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during June 1933*

TEMPERATURE (°C)

Altitude (meters) m.s.l.	Atlanta, Ga. (303 meters)[1]		Chicago, Ill. (187 meters)[2]		Cleveland, Ohio (246 meters)[2]		Dallas, Tex. (146 meters)[3]		Norfolk, Va. (3 meters)[4]		Omaha, Nebr. (300 meters)[5]		Pensacola, Fla. (2 meters)[4]		San Diego, Calif. (9 meters)[4]		Washington, D.C. (2 meters)[4]	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	20.3	(6)	18.7	(6)	17.7	(6)	21.7	(6)	23.0	+0.2	20.5	(6)	23.5	−1.5	17.4	−2.4	20.9	−1.7
500	21.8	(6)	21.8	(6)	20.0	(6)	24.5	(6)	22.1	+.8	22.2	(6)	23.5	+.2	14.5	−2.1	20.7	+.5
1,000	21.6	+2.2	21.8	+5.7	19.1	+3.0	22.9	+2.6	19.9	+.9	23.7	+5.7	21.3	+.6	16.4	−1.2	19.7	+1.8
1,500	18.1	+2.1	18.5	+5.3	15.9	+2.7	20.1	+2.1			21.2	+5.8						
2,000	14.4	+1.7	15.3	+4.7	12.9	+2.3	17.6	+2.1	13.7	+.5	18.0	+5.3	15.0	0	18.1	+1.2	13.8	+1.6
2,500	10.9	+1.3	12.2	+4.3	10.1	+2.2	14.8	+1.9			14.1	+4.4						
3,000	7.7	+1.2	8.8	+3.6	7.1	+1.9	12.0	+1.9	8.2	+.4	10.1	+3.4	8.8	−.6	12.2	+1.1	8.6	+1.9
4,000	.8	+.9	1.2	+1.4	.8	+.7	5.7	+1.3	1.7	+.4	2.8	+2.5	2.5	−.6	5.4	+1.1	2.2	+1.4
5,000	−6.2	−.1	−5.7	+.4	−5.6	+.5	−.1	+1.8			−4.3	+1.4	−4.0	−.6				

RELATIVE HUMIDITY (PERCENT)

Surface	77	(6)	79	(6)	79	(6)	74	(6)	70	−3	68	(6)	76	−4	76	+7	71	+5
500	71	(6)	61	(6)	65	(6)	60	(6)	60	−6	61	(6)	66	−8	85	+9	63	+1
1,000	61	−6	48	−19	55	−12	53	−16	56	−6	47	−17	58	−10	62	+7	59	0
1,500	62	−7	47	−19	58	−8	53	−6			42	−19						
2,000	63	−7	44	−18	51	−11	50	−1	54	−4	41	−17	57	−5	21	−2	55	−5
2,500	60	−10	40	−17	45	−12	45	−2			42	−14						
3,000	57	−11	40	−13	44	−9	42	−1	52	0	44	−10	50	−2	14	−1	47	−7
4,000	56	−4	43	−3	44	−2	43	+4	60	0	43	−9	43	−2	14	−1	36	−11
5,000	52	−3	43	+3	43	+3	37	−6			41	−11	38	−2				

Weather Bureau observations made near 5 a.m.; Navy observations near 7 a.m. (75th meridian time).

[1] Temperature and humidity departures based on normals of Due West, S.C.
[2] Temperature and humidity departures based on normals of Royal Center, Ind.
[3] Temperature departures based on normals determined by interpolating between those of Groesbeck, Tex., and Broken Arrow, Okla. Humidity departures based on normals of Groesbeck, Tex.
[4] Naval air stations.
[5] Temperature and humidity departures based on normals of Drexel, Nebr.
[6] Surface and 500-meter level departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 7 a.m. (E.S.T.) during June 1933*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m.s.l.	Albuquerque, N. Mex. (1,554 meters)		Atlanta, Ga. (309 meters)		Bismarck, N. Dak. (518 meters)		Brownsville, Tex. (12 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,873 meters)		Chicago, Ill. (192 meters)		Cleveland, Ohio (245 meters)		Dallas, Tex. (154 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (14 meters)		Key West, Fla. (11 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	1	0.6	327	1.0	87	0.9	123	0.7	186	1.6	275	3.1	227	1.3	197	1.5	171	1.8	222	0.8	240	0.5	90	2.7
500			353	2.6			157	6.2	234	3.7			268	5.8	261	4.7	192	8.5			279	2.6	102	5.4
1,000			4	2.8	190	2.9	152	6.4	297	5.1			280	6.2	292	5.8	187	6.4	235	2.1	306	1.4	112	4.5
1,500			336	1.4	225	2.8	152	5.0	295	6.7			281	5.7	296	6.9	188	4.0	270	3.4	323	1.4	124	3.7
2,000	139	1.0	322	1.6	252	3.9	128	3.4	299	7.5	258	3.8	286	6.0	306	6.8	168	2.2	267	4.3	314	.8	132	3.0
2,500	208	2.3	14	2.1	256	4.5	93	3.6	304	9.4	244	4.7	292	6.0	310	7.3	157	1.8	251	7.2	209	.1	122	2.8
3,000	237	2.7	31	2.2	252	6.0	83	4.8	310	11.9	250	5.7	291	4.2	310	7.4	155	2.2	257	8.7	249	.7	126	2.7
4,000	246	3.4	45	2.6	266	6.8	68	4.8	314	13.4	273	6.0	302	2.3	316	9.0	110	1.6	259	12.2	264	1.3	176	1.5
5,000	241	3.8	15	3.4			34	3.3			258	5.6			319	7.1	64	1.0	254	15.6	249	2.0	231	.9

	Los Angeles, Calif. (217 meters)		Medford, Oreg. (410 meters)		Memphis, Tenn. (83 meters)		New Orleans, La. (2 meters)		Oakland, Calif. (8 meters)		Oklahoma City, Okla. (402 meters)		Omaha, Nebr. (306 meters)		Phoenix, Ariz. (338 meters)		Salt Lake City, Utah (1,294 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (14 meters)		Washington, D.C. (10 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	302	0.1	311	0.6	196	0.2	11	1.0	280	2.1	174	4.7	163	1.8	89	1.5	160	4.6	114	0.5	103	1.1	337	1.1
500	112	.8	291	1.1	276	2.4	13	1.3	274	3.5	184	7.8	197	6.0	169	.4			231	2.5	109	.6	340	4.6
1,000	108	.9	318	1.4	307	1.1	85	1.2	310	5.1	212	11.2	229	9.3	231	1.3			272	5.9	165	.9	340	6.7
1,500	295	.7	341	.7	326	1.4	112	1.6	243	3.0	214	6.9	229	6.9	227	2.2	168	7.0	280	7.1	213	1.8	335	6.2
2,000	274	3.0	188	.6	13	1.4	69	1.7	196	4.0	212	4.4	230	5.2	215	3.5	182	6.5	289	8.5	216	3.1	332	6.9
2,500	251	4.0	220	3.3	36	2.0	41	2.1	192	5.6	204	2.8	247	3.4	212	5.4	211	5.0	300	10.0	211	4.3	326	7.8
3,000	248	4.7	209	4.8	38	2.5	24	2.0			192	1.4	253	3.4	220	5.7	220	5.7	310	13.6	212	6.0	322	7.9
4,000	315	2.9	206	8.0	45	3.1	345	3.1			118	1.2	267	4.1	202	5.5	223	7.6	312	18.4	212	10.6	314	7.1
5,000					59	3.9	108	4.1					305	4.3	126	2.6							314	8.2

RIVERS AND FLOODS

By MONTROSE W. HAYES

[In charge River and Flood Division]

Elsewhere in this issue there is an article which discusses all the floods of the United States during the last four months except that in the Columbia River of Oregon and Washington. The Columbia River passed above flood stage in May, but had not receded at the end of June; and information concerning it is not complete. It will be discussed in a later issue of the REVIEW.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDonald in charge]

NORTH ATLANTIC OCEAN

By W. F. McDONALD

Atmospheric pressure.—Average values of daily barometric observations at land stations representing the Atlantic area during June 1933 were for the most part within one tenth of an inch of normal. The greatest deficiency was only 0.12 inch, at Bermuda and also at Reykjavik. The Azores HIGH was somewhat above normal, but the largest excess, 0.10 inch, was reported from the Shetland Islands. (See table 1.)

The extreme range of pressures reported by ships on the trans-Atlantic routes was from 29.33 to 30.59 inches, the lower reading from the American S.S. *Quaker City*, near 59° N. 19° W. on the 4th, and the higher reading from the American S.S. *Sahale*, near 42° N. 40° W. on the 16th. The lowest reported from tropical as well as extratropical Atlantic waters during June was 29.00 inches from the American tanker *Eastern Sun*, at 16° 27′ N., 76° 15′ W., on the last day of the month. This low barometer occurred in connection with the passage of a tropical disturbance through the Caribbean Sea, noted below.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, June 1933*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	In.	*In.*	*In.*		*In.*	
Julianehaab, Greenland	29.71	.....	29.96	18, 23	29.18	3
Reykjavik, Iceland	29.76	−0.12	30.24	25	29.24	5
Lerwick, Shetland Islands	29.90	+.10	30.34	9	29.09	17
Valencia, Ireland	29.95	−.05	30.48	10	29.43	20
Lisbon, Portugal	30.04	+.01	30.21	23	29.94	6, 12
Madeira	30.11	+.04	30.23	27	30.01	7, 12
Horta, Azores	30.32	+.08	30.48	16	30.06	1
Belle Isle, Newfoundland	29.83	−.01	30.36	18	29.20	2
Halifax, Nova Scotia	29.89	−.08	30.18	25	29.66	13
Nantucket	29.91	−.07	30.19	24	29.65	30
Hatteras	29.96	−.05	30.20	15	29.71	13
Bermuda	30.01	−.12	30.26	29	29.76	2, 3
Turks Island	29.97	−.06	30.06	25, 30	29.86	1, 2
Key West	29.96	−.03	30.10	25	29.77	1
New Orleans	30.00	+.02	30.16	15	29.76	23
Cape Gracias, Nicaragua	29.85	−.02	29.90	25, 29, 30	29.80	1, 17, 20

NOTE.—All data based on a.m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Extratropical cyclones and gales.—Moderate to fresh gales were fairly widespread on the 1st, 2d, and 3d, between New York and the Irish coast. At this time vigorous but not unusually intense cyclonic depressions, along the American coast and over high latitudes, intensified the barometric gradient on the north side of a well-developed high-pressure area that dominated the region between Bermuda and Gibraltar. (See chart VIII.)

Gales of force 8 to 9 were again reported over the middle and eastern parts of the main steamer lanes on the 18th and 19th. The Azores were then under the influence of the strongest high-pressure area of the month, and these winds appear to have been due to that factor as much as to any cyclonic activity.

In fact the most remarkable feature of the month's weather on the Atlantic was the persistent and quite intense character of the Atlantic HIGH, which maintained uninterrupted dominance over the region between the Azores and Africa, and frequently extended its influence to high latitudes.

Apart from these two brief periods of gales at the beginning and shortly after the middle of the month, very few gales were encountered in extratropical latitudes, although the highest wind reported, which was of storm force (Beaufort 11), occurred near Long Island, on the 10th; this was described in the report as a violent thunder squall.

Most unusual gale conditions, not so far identified as to probable cause, were observed by the Belgian steamship *Persier* on the 26th and 27th while en voyage from Rio to Antwerp, between 9° and 15° N., and near longitude 25° W. The strong winds began from the west, and on the 26th attained a force of 7 from that direction, but the accompanying barometer was about normal, at 29.86 inches. On the 27th the winds came around to the usual direction of the trades, and blew strongly from the northeast, reaching the force of a gale (8) from east-northeast, with the barometer slightly higher than on the previous day. It is of interest to note that at the time these unusual winds were observed 2,000 miles east of Trinidad, a tropical disturbance was starting near the same latitude off the coast of South America, as described below.

Tropical cyclone.—A tropical disturbance originated a few days before the close of the month at an undetermined position over the waters north of Guiana. It was first disclosed on the morning of the 27th by a radiogram from the Brazilian steamship *Jaboatao*, reporting an easterly gale with barometer 29.27 inches, near 10° N. 59° W. This storm passed just south of Trinidad on the same afternoon, doing considerable damage there, and at 8 p.m. of that same day the American tanker *E. J. Bullock*, in the Gulf of Paria, reported a north wind of force 11, barometer 29.12, showing the storm to be fully developed, though of small extent.

The first report from a ship to reveal winds of full hurricane intensity came from the American tanker *Gulfcrest*, which was overtaken by the hurricane at 6 a.m. of the 29th, near 13° N. 70° W.; wind, SE, 12; barometer, 29.10 inches. The American tanker *Eastern Sun* was close to the center of the cyclone at 3 p.m. of the 30th, near 16° N. 76° W., where hurricane winds backed from north through west to south, and the barometer fell to 29 inches, its lowest value. That the area of hurricane winds was still of small diameter at that position is shown by reports from the American steamers *Mobile City* and *Minnesotan*, each of which had only a strong easterly gale, while the *Eastern Sun*, not more than 50 miles away, was under stress of the hurricane center.

This hurricane moved steadily northwestward after the end of June, entered the Gulf of Mexico, and turned westward to the Mexican coast a short distance south of the mouth of the Rio Grande, where it crossed the coastline and disappeared, July 6th.

A fuller discussion of this hurricane will appear in the July REVIEW.

Fog.—June was, as usual, a bad month for fog over the northern part of the Atlantic. Fogginess was reported on more than half the days of the month in several 5° squares between the Grand Banks and Cape Hatteras; on 7 to 13 days over the middle portion of the routes eastward to the 30th meridian and north of the 40th parallel; and on a few days in the region east of that meridian. Fog was reported on 1 or 2 days over mid-ocean between 35° and 40° N., and also on 2 days near the American coast southeast of Hatteras, below latitutde 35°.

Trans-Atlantic aviation.—Two noteworthy airplane crossings of the north Atlantic were successfully accomplished in June 1933. The first, in less than 24 hours, and establishing a speed record, was by the veteran American aviator James Mattern, who crossed from New York to a point near Oslo. Charts VIII and IX, for June 3 and 4, show the weather conditions attending this flight.

On June 11th two officers of the Spanish Army—Captain Barberan and Lieutenant Collar—took off from Tablada, Spain, with their objective a nonstop flight to Cuba. They landed on June 12 at Camaguey, having successfully completed the longest trans-Atlantic flight which so far has been made. Charts X and XI, for June 11 and 12 are presented to show the conditions attending this extraordinary venture.

It is noted with regret that these courageous flyers were lost a few days later on their further attempt to cross the Gulf of Mexico from Habana to Mexico City.

OCEAN GALES AND STORMS, JUNE 1933

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Independence Hall, Am. S.S.	New York	Le Havre	40 22 N	70 20 W	June 1	Noon, June 1.	June 1	29.70	NNE	NE, 7	NE	NE, 8	Steady.
Washington, Am.S.S.	Port Arthur	New York	35 28 N	75 12 W	do	do	do	29.70	N	N, 8	NE	N, 8	N-NE.
Elmsport, Am.S.S.	New Orleans	Bremen	46 05 N	29 40 W	May 31	6 p., 1	June 2	29.60	NW	NW, 8	NW	NW, 8	Steady.
Livenza, Ital.S.S.	Gibraltar	New York	41 15 N	54 26 W	June 2	10 a., 2	do	29.67	SW	SW, 8	N	SW, 8	SW-N.
Black Tern, Am.S.S.	Antwerp	Baltimore	49 31 N	26 09 W	June 3	8 p., 3	June 5	29.49	SW	SW, 7	WNW	W, 9	SSW-SW-W.
Quaker City, Am.S.S.	Dundee	Boston	58 07 N	16 10 W	do	10 p., 3	June 4	29.67	S	—, 7	S	S, 9	NW-W.
Excelsior, Am.S.S.	Casablanca	do	[1] 39 36 N	49 00 W	June 7	12 mdt, 7	June 8		SW	SW, 8	NNW	SW, 8	SW-NNW.
Statendam, Du.S.S.	New York	Rotterdam	40 27 N	72 45 W	June 10	4 a., 10	June 10	29.77	S	NW, 11	W	NW, 11	Var.
Caledonia, Br.S.S.	Glasgow	New York	55 30 N	8 00 W	June 17	12mdt, 17	June 18	28.94	WNW	WNW, 9	NW	WNW, 9	Steady.
Liberty Glo, Am.S.S.	Antwerp	Charleston	49 24 N	6 27 W	June 18	6 a., 18	June 20	29.66	NW	NW, 7	WNW	—, 8	Do.
Mar Cantabrico, Span. M.S.	Heulva	Philadelphia	40 38 N	56 48 W	do	7 p., 18	June 18	30.04	SW	SW, 9	SW	SW, 9	
Caledonia, Br.S.S.	Glasgow	New York	55 08 N	21 22 W	June 19		June 19		NW		NW	NW, 8	Steady.
Motocarline, Belg.M.S.	Aruba	Rotterdam	46 59 N	15 45 W	June 20	2 a., 21	June 22	30.04	NW	NW, 8	NW	NW, 8	
Darien, Pan.S.S.	Puerto Barrios.	Galveston	15 55 N	88 00 W	June 23	3 a., 23	June 23	29.60	SE	SE, 8	SE	SE, 8	Steady.
Persier, Belg.S.S.	Rio de Janeiro.	Antwerp	9 04 N	27 20 W	June 25	4 a., 26	June 26	29.86	W	NNW, 7	W	WNW, 7	NNW-W.
Do	do	do	14 56 N	24 52 W	June 27	4 p., 27	June 30	29.92	NNE	NNE, 7	NE	NE, 8	Steady.
Nerissa, Br.S.S.	Demerara	Port of Spain	[1] 10 05 N	62 05 W	do	8 p., 27	June 27	29.81	NE	ENE, 8	ESE	ENE, 8	NE-ENE.
Gonzenheim, Ger.S.S.	Cardiff	Newfoundl'd	52 20 N	42 40 W	June 28	8 p., 28	June 29	29.72	S	SW, 8	NW	SW, 8	SW-WSW.
Gulfcrest, Am.S.S.	New York	Las Piedras	13 17 N	69 40 W	June 29	6 a., 29	do	29.10	E	SE, 12	SE	E, 12	NE-E-SE.
Chateau Thierry, U.S.A.T.	Cristobal	San Juan	14 35 N	73 00 W	do	10 p., 29	June 30	29.64	E	SE, 8	E	SE, 8	NNE-SE.
Minnesotan, Am.S.S.	do	New York	16 45 N	75 45 W	June 30	2 p., 30	do	29.78	NE	ENE, 9	ENE	ENE, 9	NE-ENE.
Eastern Sun, Am.S.S.	Los Angeles	Philadelphia	[1] 15 50 N	76 10 W	do	3 p., 30	do	29.00	NE	NW, 12	SE	NW, 12	NNW-SW-S.
Mobile City, Am.S.S.	New York	Colon	16 45 N	75 50 W	do	do	do	29.68	E	E, —	S	SE, 9	E-SE-S.
NORTH PACIFIC OCEAN													
Silverguava, Br.M.S.	Manila	Los Angeles	36 15 N	124 42 W	June 2	7 p., June 3.	June 3	29.65	SSW	NE, 10	SE	NE, 10	ENE-N.
Fernhill, Nor.M.S.	do	do	26 57 N	130 35 E	do	7 p., 2	do	[2] 29.61	SSW	NNE, 8	NE	NNE, 8	SW-W-NNE.
Sangstad, Nor.M.S.	Los Angeles	Yokohama	34 10 N	167 40 E	June 4	7 a., 5	June 7	29.44	SE	SSE	NW	SSE, 8	SSE-W-NW.
Ogura Maru, Jap.M.S.	San Luis, Calif.	do	36 04 N	169 26 E	June 5	4 p., 5	June 5	29.45	SE	S, 6	WSW	SE, 8	SE-S-SW.
Irisbank, Br.M.S.	San Francisco.	Manila	23 27 N	137 52 E	June 15	1 p., 15	June 15	29.79	SSW	SW, 8	SW	SW, 8	SSW-SW.
Steel Exporter, Am.S.S.	Hawaiian Islands.	Balboa	13 47 N	102 00 W	do	4 a., 15	do	29.65	NE	E, 7	SW	SE, 8	NE-E-SE.
Texas, Am.S.S.	Philippine Islands.	San Francisco.	33 45 N	151 20 E	June 16	4 a., 17	June 17	29.31	SSE	SSE, 8	W	SW, 8	SE-SW.
Pres. Jackson, Am.S.S.	Honolulu	Yokohama	34 52 N	152 51 E	June 17	5 a., 17	do	29.11	SSE	SSW, 7	NW	S, 8	S-SW.
Hakubasan Maru, Jap.S.S.	Yokohama	Los Angeles	44 23 N	165 52 E	June 19	Noon, 20	June 22	29.32	SSE	SW, 8	W	SW, 8	2 points.
Grays Harbor, Am.S.S.	Philippine Islands.	do	39 37 N	174 24 E	June 28	2 p., 28	June 28	29.50	S	SSW, 9	W	SSW, 9	SSW-SW.
Makura, Br.S.S.	Papeete	San Francisco.	37 17 N	122 56 W	June 29	4 a., 30	June 30	29.87	NNW	NW, 8	NW	NW, 8	

[1] Position approximate.
[2] Barometer uncorrected.

NORTH PACIFIC OCEAN, JUNE 1933

By WILLIS E. HURD

Atmospheric pressure.—The weather over the greater part of the North Pacific Ocean during June 1933 was notably under the dominance of anticyclonic conditions. Several depressions were observed in Far Eastern waters, where the lowest average pressure of the month occurred, and several appeared over and south of the Aleutians, especially during the early days and a part of the last decade of the month. Many, however, were noted in the Bering Sea, and it was here and over Alaska that the shallow average center (St. Paul 29.90 and Point Barrow 29.88 inches) of low pressure for the extra-tropical region occurred. Departures from the normal pressures over the ocean were mostly small, as may be seen in the table herewith.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, June 1933, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.88	−0.11	30.18	3	29.50	26
Dutch Harbor	29.92	+.02	30.52	30	29.30	21
St. Paul	29.90	+.04	30.42	30	29.38	22
Kodiak	29.92	+.01	30.34	20	29.44	1
Juneau	29.94	−.07	30.41	11	29.52	1
Tatoosh Island	30.07	+.05	30.31	19	29.56	8
San Francisco	29.98	+.02	30.12	19	29.83	13
Mazatlan	29.88	−.02	29.96	4	29.78	13
Honolulu	30.07	+.03	30.16	30	29.93	10
Midway Island	30.00	+.04	30.28	30	30.00	1, 2, 10, 11
Guam	29.83	−.04	29.92	2	29.76	15, 18, 19
Manila	29.78	−.04	29.86	8	29.68	24
Naha	29.77	+.02	29.90	8, 22, 23	29.58	17
Chichishima	29.90	−.01	30.04	28	29.70	7, 15
Nemuro	29.86		30.20	27	29.54	7

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—Cyclonic activity on the North Pacific during June 1933 was mostly of a mild type. Few gales were reported and those were mostly of moderate to fresh force (7-8). The highest velocity (force 10) known to occur was experienced by the British motor ship *Silverguava* on the 3d near 36° N., 125° W., during the brief existence of a small low off the central California coast. Another gale, but of fresh force only, occurred in the same locality on the 30th. West of the 180th meridian scattered gales were encountered on a few days; only one attained a force as high as 9. Two occurred in the Far Eastern tropics due to moderate depressions of the 2d and 15th. The lowest corrected pressure of the month was 29.11 inches, reported by the American steamer *President Jackson* near 35° N., 153° E. on the 17th.

A fresh southeast gale (lowest pressure 29.65) accompanied by shifting winds, owing perhaps to a short-lived cyclone, was encountered by the American steamer *Steel Exporter*, near 14° N., 102° W.

Fog.—Fog was by far the most important meteorological element on the North Pacific this month in its adverse effect upon navigation. Along the steamer routes north of the fortieth parallel fog was reported as occurring on 2 to 8 or more days in each 5° square traversed, with the area of least prevalence lying between the Washington-Oregon coast and 145° west longitude. Along the California coast it was noted on 12 days between Eureka and Point Arguello, and on 11 days thence southward to Lower California. Along the length of the Lower California coast fog was reported on 15 days. It is evident that frequent fogs occurred in the Bering Sea, since meager reports from between the sixtieth parallel and Nome indicate its formation on at least 10 days. The American steamer *Lurline* was reported delayed by fog 1 hour on the 15th in entering Los Angeles Harbor. The British steamer *City of Vancouver* reported continuous fog and inability to take position observations from the 16th to 22d along latitudes 47°–48° N., between longitudes 169° E. and 148° W.

SOUTHWEST MONSOON IN ARABIAN SEA AND BAY OF BENGAL, JUNE 1933

According to reports received from the American steamer *Yomachichi*, the southwest monsoon was active in the Gulf of Aden and the Arabian Sea during the early part of June. On the 10th, east of Sokotra Island, the observed velocity had risen to force 8.

The British motor ship *Cingalese Prince*, crossing the lower waters of the Bay of Bengal to Ceylon from the 17th to 20th, reported a steady monsoon current of moderate force. On the 25th and 26th, between longitudes 60° and 55° E., the force of the southwesterly winds ranged generally between 7 and 9, but rose at times to whole gale force (10).—W. E. H.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, June 1933

[For description of tables and charts, see REVIEW, January, p. 37]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	78.5	+0.3	Brewton	109	17	Riverton	45	15	3.04	−1.28	Bay Minette	8.71	Decatur	0.34
Arizona	77.6	−.3	Gila Bend	120	11	2 stations	25	[1] 1	.48	+.02	Paradise	2.93	14 stations	.00
Arkansas	78.4	+1.4	2 stations	107	[1] 23	do	40	[1] 13	1.30	−2.71	Freeman Springs	3.61	2 stations	.00
California	65.7	−2.5	Greenland Ranch	120	16	Madeline	20	17	.22	−.10	Crescent City (near)	6.12	60 stations	.00
Colorado	66.0	+4.5	Las Animas	111	30	Pearl	21	1	.91	−.51	Westcliffe	6.02	2 stations	.00
Florida	79.1	−.7	2 stations	105	[1] 7	2 stations	49	3	5.23	−1.39	Bartow	13.47	Long Key	.34
Georgia	79.3	+1.3	Eastman	108	20	Blairsville	34	15	2.96	−1.47	Savannah No. 2	9.05	Goat Rock	.49
Idaho	64.2	+3.9	Grand View	107	13	Pelton Ranch	26	30	.99	−.23	Grangeville	4.80	Jerome	.00
Illinois	78.1	+6.6	Greenville	106	30	Waukegan	37	14	1.48	−2.60	Warsaw	5.96	3 stations	T
Indiana	77.2	+5.8	2 stations	108	[1] 24	Marengo	34	15	1.16	−2.65	Whiting	4.37	Farmland	.02
Iowa	77.8	+8.3	Denison	109	10	Webster City	34	14	1.64	−2.99	Keokuk No. 2	7.97	Chariton	T
Kansas	80.7	+7.1	2 stations	114	30	Sedan	42	14	.87	−3.13	Horton	4.71	2 station	.00
Kentucky	76.5	+2.7	Franklin	105	21	Middlesboro	39	[1] 14	1.57	−2.54	High Bridge	5.97	Irvington	T
Louisiana	78.9	−1.1	Dodson	105	[1] 21	Robeline	45	15	1.94	−2.70	Crowley	5.79	2 stations	.00
Maryland-Delaware	72.5	+1.7	Cumberland, Md.	102	[1] 8	Oakland, Md.	28	15	2.73	−1.22	Westminister, Md.	5.13	Crisfield, Md.	.58
Michigan	69.8	+6.2	2 stations	103	28	Wolverine	22	14	2.31	−.81	Eau Claire	5.10	Croswell	.13
Minnesota	72.5	+7.6	Beardsley	109	25	2 stations	30	14	2.04	−2.01	Orr	4.56	Albert Lea	.23
Mississippi	78.8	.0	3 stations	105	[1] 20	Duck Hill	43	15	1.79	−2.35	Poplarville	5.42	Hernando	.04
Missouri	78.4	+5.0	2 stations	107	[1] 25	Goodland	38	15	1.72	−3.07	Gorin	9.10	2 stations	.00
Montana	65.5	+5.8	Kenilworth (near)	107	17	3 stations	26	[1] 2	1.58	−.93	Turner	4.19	Crow Agency	.00
Nebraska	77.7	+8.7	Beaver City	113	30	Weeping Water	39	12	1.03	−2.75	Weeping Water	3.44	Potter	.00
Nevada	67.1	+2.8	Clay City	110	[1] 12	Zorra Vista Ranch	25	[1] 17	.06	−.43	Minden	.40	12 stations	.00
New England	65.9	+2.1	2 stations	103	29	Pittsburg, N. H.	25	2	2.24	−1.09	Hanover, N.H.	5.90	Newport, Vt.	.66
New Jersey	71.0	+2.2	Elizabeth	105	10	Layton	32	2	2.79	−.92	Runyon	5.71	Belleplain	.52
New Mexico	69.2	+.3	3 stations	110	[1] 4	Selsor Ranch	22	[1] 7	2.14	+.87	Mountain Park	6.91	Glenrio	T
New York	68.0	+3.1	4 stations	102	29	Indian Lake	27	2	2.12	−1.52	Scio	8.12	High Market	.47
North Carolina	75.3	+1.4	2 stations	106	21	Mount Mitchell	28	14	2.44	−2.30	Stonewall	6.20	Caroleen	.41
North Dakota	70.7	+8.2	Fort Yates	110	18	Eckman	33	12	1.75	−1.70	Valley City	4.49	Hettinger	.38
Ohio	74.4	+5.0	3 stations	103	[1] 8	Dennison	31	15	1.78	−2.00	Circleville	4.60	Xenia	.26
Oklahoma	80.6	+3.5	Jefferson	113	5	5 stations	45	[1] 8	.42	−3.38	Smithville	2.67	5 stations	.00
Oregon	60.6	+1.1	Blitzen	105	14	Fremont	18	19	1.43	+.22	Brookings	10.60	Danner	.00
Pennsylvania	70.9	+3.0	Sharon	107	8	Somerset	28	15	2.58	−1.60	Bloserville	6.57	New Castle	.67
South Carolina	78.5	+1.1	2 stations	106	21	2 stations	43	15	2.74	−2.03	Florence No. 1	6.30	Winthrop College	.57
South Dakota	76.5	+10.0	4 stations	111	26	Castlewood	33	13	1.48	−2.07	Bowdle	3.96	Pine Ridge	.23
Tennessee	76.0	+1.4	2 stations	105	[1] 20	2 stations	36	15	1.79	−2.43	Elkmont	4.51	Kenton	.23
Texas	80.3	+.1	4 stations	109	[1] 4	Wiergate	42	13	.77	−2.43	George West	5.97	25 stations	.00
Utah	68.5	+4.0	Hanksville	110	26	Soldiers Summit	22	6	.06	−.51	Escalante	.80	20 stations	.00
Virginia	73.0	+2.0	Clerksville	104	22	Burkes Garden	35	[1] 14	2.11	−2.11	Emporia	5.60	Timberville	.48
Washington	59.6	−.8	3 stations	105	[1] 11	Stockdill Ranch	22	10	1.42	−.19	Cougar	5.74	Kennewick	.04
West Virginia	71.4	+1.9	Wheeling	104	8	2 stations	28	15	2.75	−1.62	Richwood	7.08	Benson	.52
Wisconsin	72.6	+7.5	Hancock	106	27	Coddington	26	14	2.62	−1.41	Manitowoc	7.55	Meadow Valley	.60
Wyoming	64.3	+5.7	Pine Bluffs	104	27	South Pass City	18	8	.56	−1.06	Devil's Tower	2.70	4 stations	.00
Alaska (May)	41.7	+.3	Fairbanks (near)	82	26	Savoonga	−4	1	1.35	−.22	View Cove	7.01	Hot Springs	T
Hawaii	72.2	−1.3	Haiku	91	20	Kanalohuluhulu	45	16	3.79	−1.49	Hilon-Manawaio-puna Divide.	24.00	9 stations	.00
Puerto Rico	78.5	+.2	Dorado	95	3	Guineo Reservoir	48	8	6.78	+.54	San Sebastian	18.94	Jayuya	2.67

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, June 1933*

[Compiled by Annie E. Small]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
New England							65.4	+1.8										75	2.40	−0.6										5.1		
Eastport	76	67	85	29.80	29.88	−0.05	55.8	+0.7	83	10	64	39	2	48	33	51	49	83	3.18	+.2	14	6,518	sw.	30	e.	18	6	13	11	6.3	0.0	0.0
Greenville, Maine	1,070	6		28.73	29.88		61.2		89	28	73	34	16	50	41				3.33		10	4,618	se.	19		1	6	13	11		.0	.0
Portland, Maine	103	82	117	29.77	29.89	−.06	64.6	+2.1	93	12	73	45	2	56	34	58	54	71	1.61	−1.7	12	6,278	s.	23	nw.	17	15	11	4	3.9	.0	.0
Concord	289	70	79	29.59	29.89	−.07	66.9	+4.0	98	9	80	36	2	54	43				1.25	−1.9	6	4,265	nw.	19	nw.	17	18	9	3	3.3	.0	.0
Burlington	403	11	48	29.48	29.90	−.06	66.5	+.8	94	28	77	37	2	56	37				2.59	−.8	9	6,091	s.	32	se.	28	9	12	9	5.5	.0	.0
Northfield	876	12	60		29.90	−.06	62.6	+1.3	94	28	76	32	2	49	42			76	1.32	−1.9	12	5,018	s.	25	sw.	30	7	13	10	5.8	.0	.0
Boston	125	106	165	29.76	29.89	−.07	69.6	+3.1	99	29	80	47	2	60	37	61	55	64	1.22	−1.7	10	6,345	sw.	29	sw.	9	8	16	6	5.1	.0	.0
Nantucket	12	14	90	29.90	29.91	−.07	62.8	+1.8	81	9	70	48	3	56	20	58	56	83	4.78	+2.1	10	9,193	s.	40	sw.	10	9	14	7	5.2	.0	.0
Block Island	26	11	46	29.89	29.92	−.05	63.4	+1.6	78	22	69	49	2	58	17	60	58	87	3.13	+.5	11	8,776	s.	32	sw.	12	11	9	10	5.5	.0	.0
Providence	160	215	251	29.74	29.91	−.06	68.2	−.1	94	12	78	45	2	59	31	60	55	67	2.85	+.2	12	7,625	nw.	31	nw.	12	12	11	7	4.8	.0	.0
Hartford	159	70	104	29.74	29.91	−.06	69.5	+2.4	95	29	80	44	2	59	37				2.18	−.9	9		sw.				11	11	8	5.1	.0	.0
New Haven	106	74	153	29.81	29.92	−.05	69.2	+2.6	94	12	78	47	2	60	33	62	57	69	2.26	−.8	9	6,133	s.	24	n.	1	9	14	7	5.3	.0	.0
Middle Atlantic States							72.9	+2.5										68	2.75	−0.9										4.9		
Albany	97	107	115	29.81	29.91	−.06	71.4	+3.4	100	9	82	43	2	61	35	63	59	69	2.21	−1.2	9	5,507	s.	22	n.	1	6	20	4	5.2	.0	.0
Binghamton	871	60	68	29.03	29.94	−.03	68.8	+3.2	98	29	81	39	2	57	37				1.91	−1.5	11	3,950	nw.	21	sw.	30	7	8	15	6.5	.0	.0
New York	314	414	454	29.59	29.92	−.06	70.8	+2.0	96	9	79	47	15	62	29	63	59	71	2.55	−.8	10	9,326	n.	67	nw.	10	7	14	9	5.5	.0	.0
Bellefonte	1,050	5	42	28.86	29.95		68.3		93	8	82	38	2	55	38	58	59	73	2.87		10		sw.				5	20	5	5.6	.0	.0
Harrisburg	374	94	104	29.54	29.93	−.06	73.4	+3.1	97	9	84	48	15	63	34	64	59	64	3.46	−.1	12	4,885	w.	37	w.	9	7	15	8	5.1	.0	.0
Philadelphia	114	123	367	29.82	29.95	−.03	74.4	+3.0	98	9	84	50	15	65	32	64	59	62	4.78	+1.5	10	8,481	sw.	36	nw.	7	11	13	6	4.9	.0	.0
Reading	323	283	304	29.59	29.94		72.4	+2.6	98	9	83	45	15	62	36	64	58	63	1.77	−1.8	9	7,108	nw.	58	nw.	7	8	15	7	5.3	.0	.0
Scranton	805	72	104	29.09	29.93	−.05	70.2	+2.4	96	9	82	41	2	59	38	61	56	62	2.92	−.8	10	4,663	sw.	32	nw.	7	7	19	4	4.9	.0	.0
Atlantic City	52	37	172	29.88	29.93	−.05	69.8	+3.2	91	22	77	47	15	63	27	64	60	76	1.84	−1.2	6	9,864	s.	38	se.	7	13	9	8	5.0	.0	.0
Sandy Hook	22	10	55	29.90	29.92		69.6		91	9	77	51	15	62	28	64	60	77	4.59	+.8	12	8,423	sw.	50	sw.	5	13	12	5	4.4	.0	.0
Trenton	190	159	183	29.73	29.93		72.0	+2.5	99	9	83	45	15	61	35	64	60	68	2.93	−.2	11	6,314	s.	32	nw.	7	10	15	5	5.0	.0	.0
Baltimore	123	100	215	29.81	29.94	−.05	76.0	+3.3	98	9	86	50	15	66	32	66	61	61	3.09	−.8	10	7,069	sw.	41	nw.	7	13	11	6	4.6	.0	.0
Washington	112	62	85	29.83	29.94	−.06	74.7	+2.5	100	9	85	47	15	64	34	66	61	65	3.88	−.2	12	4,296	nw.	30	nw.	22	14	11	5	4.2	.0	.0
Cape Henry	18	8	54	29.93	29.95		74.4	+1.5	95	20	82	51	16	67	30	68	64	74	2.03	−1.9	6	7,641	se.	41	n.	17	9	17	4	4.7	.0	.0
Lynchburg	681	153	188	29.24	29.97	−.04	76.0	+1.4	100	22	88	48	15	64	36	68	64	68	2.61	−1.2	5	4,117	nw.	24	ne.	8	18	11	1	3.7	.0	.0
Norfolk	91	170	205	29.87	29.96	−.04	76.8	+2.4	99	22	86	52	16	67	28	67	62	68	2.05	−2.2	7	7,446	s.	34	w.	25	8	15	7	5.8	.0	.0
Richmond	144	11	52	29.82	29.96	−.05	75.8	+1.7	100	22	87	48	15	64	38	67	62	66	1.63	−2.3	6	5,041	ne.	22	n.	6	14	11	5	4.0	.0	.0
Wytheville	2,304	49	55	27.68	29.98	−.03	69.8	+1.1	94	8	82	38	15	58	34	62	57	68	2.50	−1.7	8	4,091	w.	18	w.	17	14	13	3	3.9	.0	.0
South Atlantic States							78.1	+1.7										66	2.35	−2.3										4.5		
Asheville	2,253	89	104	27.73	30.00	−.01	72.3	+3.6	97	8	85	42	15	60	38	63	58	66	3.28	−.6	7	4,592	nw.	21	n.	9	10	14	6	5.0	.0	.0
Charlotte	779	244	267	29.17	29.99	−.02	78.3	+2.8	98	21	88	51	15	68	26	66	59	56	1.31	−2.9	9	7,184	n.	32	n.	6	12	16	2	4.1	.0	.0
Greensboro	886	6	56	29.06	29.99		75.7		100	21	89	42	15	62	40	66	60	61	.32		5	4,795	n.	29	nw.	6	10	16	4	4.5	.0	.0
Hatteras	11	5	50	29.94	29.95	−.06	75.1	−.5	88	20	81	58	16	69	22	70	68	80	.77	−3.8	4	8,693	sw.	32	n.	1	15	9	6	4.3	.0	.0
Raleigh	376	103	146	29.58	29.96	−.05	77.9	+2.2	101	21	89	49	15	67	33	66	60	59	1.44	−3.0	7	5,847	n.	37	nw.	6	11	11	8	4.9	.0	.0
Wilmington	72	73	106	29.91	29.98	−.03	77.5	+.7	98	21	87	51	3	68	33	69	66	73	1.61	−3.5	4	6,275	sw.	27	nw.	6	13	10	7	4.4	.0	.0
Charleston	48	11	92	29.94	30.00	−.01	79.6	+.7	99	5	87	59	15	72	27	71	68	74	2.72	−1.9	13	7,253	sw.	37	n.	6	12	10	8	4.6	.0	.0
Columbia, S.C.	351	41	57	29.62	29.99	−.02	80.2	+2.1	100	20	92	55	15	69	31	68	62	62	1.21	−3.0	6	4,262	sw.	22	ne.	6	13	13	4	4.2	.0	.0
Greenville, S.C.	1,039	139	146	28.92	29.98		78.8	+4.7	98	7	89	52	15	68	31	60	60	57	1.59	−3.0	4	5,398	n.	32	sw.	24	14	12	4	4.2	.0	.0
Augusta	182	62	77	29.79	29.98	−.03	81.0	+2.3	103	19	93	53	16	69	35	70	65	64	.90	−3.8	9	4,218	s.	18	nw.	25	11	14	5	4.5	.0	.0
Savannah	65	73	152	29.92	30.00	−.01	79.7	+.7	99	20	90	59	15	70	30	70	66	71	4.15	−1.1	10	7,004	sw.	32	nw.	1	14	6	10	4.0	.0	.0
Jacksonville	43	209	245	29.95	30.00	−.01	79.0	−.9	94	20	87	62	16	71	26	70	66	71	6.84	+1.5	12	7,245	sw.	34	nw.	13	9	13	8	5.0	.0	.0
Florida Peninsula							80.2	−0.5										76	8.27	+2.1										5.2		
Key West	22	10	64	29.94	29.96	−.03	80.8	−1.1	89	14	86	69	4	76	19	75	73	78	10.91	+6.7	13	6,642	e.	19	e.	18	11	11	8	5.0	.0	.0
Miami	25	124	168	29.97	30.00	.00	80.4	+.4	91	15	85	66	3	76	23	74	71	76	9.39	+2.5	11	6,965	se.	25	s.	15	8	7	15	6.6	.0	.0
Tampa	35	88	197	29.96	29.99	−.02	79.5	−.7	95	7	88	62	3	71	27	71	68	73	4.50	−2.8	13	7,112	e.	29	ne.	15	10	12	8	4.4	.0	.0
Titusville	44	5		29.94	29.99		79.2		96	7	88	61	3	70	28				7.72		13		se.				15	6	9	4.6	.0	.0
East Gulf States							79.6	+0.5										64	3.38	−1.3										4.0		
Atlanta	1,173	196	198	28.79	30.00	−.01	78.0	+2.0	99	19	88	56	14	68	26	66	59	58	5.65	+1.9	7	5,908	w.	23	se.	10	12	11	7	4.6	.0	.0
Macon	370	76	84	29.60	29.99	−.02	79.2	+.3	100	7	91	53	16	68	36	68	62	60	1.62	−2.4	9	4,352	s.	21	n.	10	14	9	7	4.5	.0	.0
Thomasville	273	49	103	29.71	30.00	.00	79.8	+.3	100	19	91	58	16	69	32	69	64	67	1.96	−3.5	8	5,367	sw.	26	w.	28	13	10	7	4.4	.0	.0
Apalachicola	36	11	51	29.96	30.00		80.6		95	7	88	66	16	72	24	72	68	70	4.78	−.8	3	6,130	s.	27	e.	22	16	11	3	3.2	.0	.0
Pensacola	56	149	185	29.94	30.00	+.01	78.4	−.9	99	20	85	62	2	72	26	71	68	72	2.87	−1.8	9	8,287	sw.	38	se.	8	15	14	1	3.1	.0	.0
Anniston	741	9	57				77.9	+2.9	103	20	92	48	15	64	41				2.05		7		nw.				12	11	7		.0	.0
Birmingham	700	11	48	29.26	30.01	+.02	78.6	+.7	102	21	91	52	14	66	32	66	61	63	2.65	−1.8	9	3,974	n.	21	se.	8	14	9	7	4.2	.0	.0
Mobile	57	125	161	29.94	30.00	+.01	79.4	−.9	98	19	88	60	15	70	28	69	65	67	5.90	+.5	7	6,426	n.	24	w.	28	15	9	6	3.8	.0	.0
Montgomery	218	92	105	29.76	30.00	.00	80.1	+.5	103	19	91	57	15	69	32	68	61	60	4.07	+.3	10	4,499	w.	23	sw.	11	12	7	11	5.1	.0	.0
Corinth	469	6					79.4		104	21	93	48	15	66	40				1.14		6		se.				15	14	1		.0	.0
Meridian	375	87	95	29.62	30.00	+.02	77.8	−.3	99	21	89	55	15	66	34	67	62	64	5.12	+.6	7	3,722	sw.	34	e.	8	15	8	7	3.9	.0	.0
Vicksburg	247	68	73	29.75	30.01	+.04	78.6	−.4	97	22	88	59	15	70	24	69	64	64	1.96	−2.0	4	4,774	sw.	22	nw.	9	17	6	7	3.4	.0	.0
New Orleans	53	76	84	29.95	30.00	+.02	81.6	+1.0	99	20	90	64	15	74	23	70	65	62	.59	−5.3	4	4,568	sw.	23	ne.	21	16	11	3	3.4	.0	.0
West Gulf States							80.4	+0.7										63	0.83	−2.6										2.8		
Shreveport	249	92	227	29.74	30.00	+.04	81.5	+.8	102	21	92	58	15	71	27	69	63	59	.15	−3.4	4	6,499	s.	30	s.	11	22	7	1	2.3	.0	.0
Bentonville	1,303	11	44	28.63	29.96	+.02	77.1	+3.0	100	25	91	47	14	64	35				.14		1	3,803	sw.	16	ne.	12	20	7	3		.0	.0
Fort Smith	457	79	94	29.50	29.97	+.03	80.8	+3.3	104	25	93	57	14	68	32	68	62	59	.72	−3.0	4	4,559	ne.	31	sw.	26	20	6	4	2.8	.0	.0
Little Rock	357	94	102	29.63	30.00	+.04	79.4	+2.0	100	22	90	55	16	69	29	68	61	59	.99	−2.8	4	5,034	sw.	21	s.	23	19	8	3	2.9	.0	.0
Austin	605	136	148	29.34	29.97		80.4	−.8	101	23	92	57	16	69	29	68	62	59	.41	−2.0	2	5,595	se.	21	s.	29	21	7	2	2.6	.0	.0
Brownsville	57	88	96	29.88	29.94		81.2	−1.2	97	23	89	68	16	73	26	73	70	75	.41	−2.5	2	6,666	se.	21	e.	14	21	6	3	3.3	.0	.0
Corpus Christi	20	11	78	29.97	29.99	+.08	80.6	−.4	95	22	87	69	16	75	23	73	71	75	2.72	+.1	6	7,568	se.	21	se.	30	18	5	7	4.0	.0	.0
Dallas	512	220	227	29.44	29.98		81.0		101	25	90	62	16	72	25				T	−3.9	0	7,526	se.	38	ne.	11	27	2	1	1.5	.0	.0
Fort Worth	670	106	114	29.26	29.96	+.04	81.6	+1.7	104	25	93	59	15	70	30	67	59	51	.03	−3.3	2	6,543	s.	22	ne.	11	21	7	2	2.8	.0	.0
Galveston	54	106	114	29.94	30.00	+.05	81.5	+.8	96	22	86	68	15	77	20	72	68	68	.98	−3.4	5	6,899	s.	26	nw.	10	22	6	2	2.3	.0	.0
Houston	138	292	314	29.86	30.00		80.8	−.6	98	20	90	61	15	72	27				1.85	−2.7	6	7,738	s.	32	se.	23	20	8	2	3.0	.0	.0
Palestine	510	64	72	29.48	30.00	+.06	79.4	+.4	100	22	90	57	15	69	27	68	62	61	.38	−3.2	2	5,073	s.	22	s.	27	22	6	2	2.4	.0	.0
Port Arthur	34	58	66	29.96	30.00		80.8		97	20	89	60	15	73	25	71	68	67	1.01	−3.8	3	5,456	s.	29	nw.	23	17	12	1	3.2	.0	.0
San Antonio	693	242	301	29.25	29.95	+.05	80.9	−.1	99	25	92	62	15	70	26	69	64	64	1.74	−.7	4	8,358	se.	30	se.	27	18	9	3	3.4	.0	.0
Taylor	571	38	51	29.40	30.00	+.08	79.9	−.1	101	22	92	55	15	68	30				.24	−1.8	2	6,170	s.	21	e.	10	24	5	1	2.0	.0	.0

TABLE 1.—*Climatological data for Weather Bureau stations, June 1933*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min./2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	*H*	*In.*	*In.*		*Miles*							*0–10*	*In.*	*In.*
							76.8	+4.0										60	1.89	−2.0										3.5		
Chattanooga	762	190	215	29.22	30.02	+0.02	77.6	+2.2	100	8	89	54	15	67	32	66	61	61	1.44	−2.7	7	4,798	sw.	30	se.	30	11	13	6	4.5	0.0	0.0
Knoxville	995	79	97	28.98	30.00	.00	77.2	+3.2	100	8	89	51	14	66	32	66	61	60	3.29	−.8	5	4,118	n.	21	nw.	12	20	6	4	3.2	.0	.0
Memphis	399	78	86	29.59	30.00	+.03	80.3	+2.7	99	22	89	56	15	72	23	68	62	58	.30	−3.2	5	4,641	sw.	32	n.	26	19	9	2	2.8	.0	.0
Nashville	546	168	191	29.46	30.03	+.04	77.8	+2.2	99	7	90	52	16	66	32	68	62	63	1.76	−2.2	6	5,177	w.	40	nw.	12	15	10	5	3.7	.0	.0
Lexington	989	193	230	28.99	30.03	+.03	76.5	+4.3	95	7	87	47	14	66	27				4.56	+.5	7	7,615	sw.	41	nw.	12	25	5	0	1.6	.0	.0
Louisville	525	188	234	29.44	30.01	+.03	79.0	+4.3	98	30	89	48	14	69	26	67	60	56	.67	−3.2	3	6,475	s.	34	se.	28	15	13	2	3.6	.0	.0
Evansville	431	76	116	29.54	30.00	+.03	80.5	+5.4	100	30	91	50	14	70	28	68	61	55	.38	−3.7	2	5,464	sw.	23	nw.	26	17	12	1	3.0	.0	.0
Indianapolis	822	194	230	29.12	29.98	+.01	78.4	+6.8	98	24	89	46	14	67	34	66	58	52	2.50	−1.1	6	6,740	sw.	41	ne.	6	16	10	4	3.3	.0	.0
Terre Haute	575	96	129	29.38	29.98		79.2		102	30	90	48	14	68	28	66	60	54	.03	−3.9	2	5,984	sw.	25	sw.	30	21	8	1	2.3	.0	.0
Cincinnati	627	11	51	29.33	30.00	+.01	77.6	+6.4	98	21	89	46	14	66	30	66	61	62	3.30	−.4	6	4,797	sw.	30	nw.	30	16	10	4	3.5	.0	.0
Columbus	822	216	230	29.13	29.98	−.01	76.1	+5.2	98	8	87	47	15	65	30	65	58	58	1.71	−1.6	11	6,746	sw.	32	nw.	6	15	14	1	3.5	.0	.0
Dayton	899	137	173	29.05	29.98		77.5	+6.1	97	21	89	46	14	66	31	66	58	55	1.00	−2.8	3	5,836	sw.	28	ne.	6	17	12	1	3.0	.0	.0
Elkins	1,947	59	67	28.03	30.02	+.02	67.6	+.7	93	9	80	38	14	55	36	61	58	76	5.02	.0	15	3,486	nw.	30	nw.	3	7	14	9	5.8	.0	.0
Parkersburg	637	77	82	29.37	30.02	+.02	75.2	+3.8	98	8	87	41	15	64	36	66	61	65	1.24	−2.8	9	3,880	se.	32	se.	9	13	15	2	4.2	.0	.0
Pittsburgh	842	353	410	29.10	29.98	−.01	73.3	+2.6	96	8	84	41	15	63	30	62	57	59	1.16	−2.6	5	6,346	w.	38	nw.	3	11	12	7	5.0	.0	.0
Lower Lake Region							71.3	+4.6										64	1.37	−2.0										4.3		
Buffalo	767	243	280	29.12	29.94	−.03	67.1	+2.7	97	29	75	44	13	60	27	61	57	72	1.51	−1.3	8	8,443	sw.	54	w.	7	14	9	7	4.7	.0	.0
Canton	448	10	61	29.42	29.88		66.8	+1.0	95	28	79	39	1	55	34				2.11	−1.2	7	5,217	sw.	39	nw.	28	12	12	6	4.6	.0	.0
Ithaca	836	74	100	29.04	29.93		70.1	+3.9	102	29	83	39	2	57	39	62	57	67	3.07	−.5	10	5,578	nw.	32	nw.	21	9	12	9	5.4	.0	.0
Oswego	335	71	85	29.56	29.92	−.05	67.0	+2.2	90	11	76	46	2	58	29	61	56	69	.84	−2.4	9	5,733	w.	24	n.	14	10	13	7	4.8	.0	.0
Rochester	523	86	102	29.38	29.94	−.03	70.2	+4.1	97	28	80	43	15	60	31	61	56	62	1.34	−1.7	11	5,716	sw.	30	sw.	30	16	9	5	4.3	.0	.0
Syracuse	596	65	79	29.31	29.95	−.02	70.5	+3.6	96	28	81	45	2	60	35				1.58	−2.3	8	4,887	nw.	21	nw.	3	8	11	11	5.7	.0	.0
Erie	714	130	166	29.20	29.96	−.02	71.0	+4.8	95	21	80	44	15	62	28	65	62	73	1.75	−1.6	6	7,900	w.	38	n.	7	17	8	5	3.7	.0	.0
Cleveland	762	267	337	29.16	29.96	−.02	73.0	+5.9	98	8	81	47	15	65	27	63	56	58	.39	−2.7	5	8,117	w.	36	sw.	30	11	15	4	4.4	.0	.0
Sandusky	629	5	67	29.31	29.98	.00	74.4	+5.6	100	8	85	45	15	64	36				1.11	−2.4	7	5,483	sw.	22	sw.	30	12	14	4	4.0	.0	.0
Toledo	628	79	87	29.30	29.97	.00	75.4	+6.7	99	28	86	46	14	65	33	64	58	57	1.02	−2.3	9	6,147	w.	26	w.	30	20	8	2	2.4	.0	.0
Fort Wayne	857	69	84	29.06	29.97		76.0	+7.5	97	7	88	44	14	64	33	65	58	56	.50	−3.1	6	5,741	sw.	28	nw.	25	15	11	4	3.6	.0	.0
Detroit	730	218	258	29.19	29.96	−.01	74.6	+7.2	100	8	85	48	13	64	34	63	57	58	1.19	−2.4	9	6,348	sw.	28	nw.	21	11	14	5	4.4	.0	.0
Upper Lake Region							68.6	+6.2										63	2.44	−0.8										4.3		
Alpena	609	13	89	29.29	29.95	−.01	65.0	+4.6	100	27	75	40	14	55	41	59	55	72	2.02	−1.3	9	6,545	se.	41	nw.	11	13	14	3	3.7	.0	.0
Escanaba	612	54	60	29.28	29.93	−.01	66.3	+5.6	93	30	75	40	14	58	30	60	57	73	2.34	−.9	11	6,184	s.	28	ne.	7	11	14	5	4.5	.0	.0
Grand Haven	632	54	89	29.28	29.94	−.02	68.5	+4.8	94	28	78	41	14	59	26	62	57	68	2.65	−.3	8	6,629	sw.	29	w.	30	12	7	11	4.9	.0	.0
Grand Rapids	707	70	244	29.21	29.96	−.01	74.0	+6.2	97	27	85	42	14	63	33	65	60	62	2.05	−1.4	8	7,204	sw.	32	sw.	15	13	11	6	4.1	.0	.0
Houghton	668	64	99	29.20	29.91	−.03	66.0	+6.0	99	19	78	44	14	54	47				1.93	−1.0	8	6,644	e.	34	sw.	8	8	19	3	4.9	.0	.0
Lansing	878	6	88	29.03	29.95		71.6	+5.2	96	28	84	40	14	59	37	65	61	71	2.56	−1.0	9	5,713	s.	29	sw.	4	18	9	3	3.7	.0	.0
Ludington	637	60	66	29.26	29.95		66.2	+5.7	87	27	75	39	14	58	25	61	56	69	1.82	−1.1	14	5,664	sw.	22	nw.	11	19	8	3	3.1	.0	.0
Marquette	734	77	111	29.12	29.92	−.02	64.8	+5.9	98	19	77	43	1	53	38	58	54	69	1.32	−1.9	11	5,790	w.	30	w.	8	9	17	4	4.8	.0	.0
Port Huron	638	79	120	29.27	29.95	−.02	69.8	+5.6	97	27	81	44	13	58	38	62	57	66	1.39	−1.4	7	6,379	sw.	30	n.	11	13	10	7	4.5	.0	.0
Sault Sainte Marie	614	11	52	29.26	29.94	−.02	63.4	+4.8	91	8	76	35	14	51	41	57	53	71	2.29	−.6	8	4,668	se.	31	nw.	12	12	13	5	4.6	.0	.0
Chicago	673	7	131	29.25	29.97	+.01	76.2	+8.9	100	27	86	51	14	67	33	65	59	60	3.44	+.1	4	6,700	sw.	37	w.	4	18	7	5	3.3	.0	.0
Green Bay	617	109	141	29.26	29.91	−.04	72.9	+8.0	98	27	85	42	14	61	35	65	60	67	5.07	+1.4	12	6,833	sw.	37	ne.	11	10	11	9	5.1	.0	.0
Milwaukee	681	97	221	29.22	29.95	.00	73.1	+9.2	101	27	83	47	14	63	35	63	58	62	2.47	−.9	9	8,024	w.	35	n.	11	13	10	7	4.2	.0	.0
Duluth	1,133	5	47	28.70	29.90	−.02	63.2	+6.0	95	19	76	40	1	51	36	57	53	72	2.90	−1.0	12	7,205	ne.	29	nw.	27	11	14	5	4.6	.0	.0
North Dakota							71.6	+8.5										56	1.66	−1.9										4.0		
Moorhead	940	50	58	28.86	29.85	−.05	72.8	+8.4	104	18	86	44	13	59	42	62	55	56	2.13	−1.9	9	5,898	s.	29	nw.	28	13	13	4	4.4	.0	.0
Bismarck	1,674	8	57	28.10	29.84	−.03	73.2	+9.5	106	18	86	46	13	60	43	61	53	55	1.95	−1.4	11	6,073	se.	29	w.	18	11	17	2	4.3	.0	.0
Devils Lake	1,478	11	44	28.32	29.86	−.02	70.2	+8.3	103	18	83	42	12	57	39	60	53	58	.96	−2.6	10	6,099	s.	30	nw.	5	13	12	5	4.4	.0	.0
Grand Forks	833	12	67				71.1		105	18	85	40	13	57	39	62			2.01		8		nw.	43	ne.	29	7	17	6		.0	.0
Williston	1,878	41	48	27.91	29.83	−.03	70.4	+7.7	100	17	83	47	11	58	37	59	52	55	1.60	−1.8	8	5,245	se.	32	e.	28	18	9	3	3.0	.0	.0
Upper Mississippi Valley							78.7	+8.2										58	1.97	−2.1										3.4		
Minneapolis	918	102	208	28.90	29.86		77.9	+10.4	100	19	89	49	13	67	32				1.31	−2.9	6	6,796	s.	38	n.	11	14	10	6	4.1	.0	.0
St. Paul	837	114	149	29.00	29.88	−.04	77.8	+10.7	99	27	89	49	14	66	32				.92	−3.2	6	5,772	sw.	35	sw.	7	15	12	3	3.5	.0	.0
La Crosse	714	11	48	29.14	29.89	−.04	76.5	+8.2	102	20	89	42	14	64	35	67	62	65	2.11	−2.0	8	3,500	s.	20	sw.	8	12	13	5	4.0	.0	.0
Madison	974	70	78	28.91	29.93	−.01	76.0	+8.8	97	27	86	45	14	66	31	65	59	59	1.64	−2.1	4	5,691	sw.	25	se.	27	14	9	7	4.3	.0	.0
Wausau	1,247	4	62	28.63	29.93		73.8		100	27	87	38	14	61	41				2.73	−1.3	10	4,466	s.	28	nw.	11	19	11	0	2.8	.0	.0
Charles City	1,015	10	51	28.87	29.91	.00	76.2	+9.7	101	30	90	42	14	62	40	66	60	58	1.74	−2.9	8	4,994	se.	20	sw.	9	15	13	2	3.5	.0	.0
Davenport	606	118	143	29.31	29.96	+.02	79.6	+9.1	100	26	91	49	13	68	29	67	60	56	3.12	−1.0	7	6,539	sw.	38	n.	23	17	9	4	3.6	.0	.0
Des Moines	861	5	99	29.03	29.91	−.01	79.8	+9.2	103	6	93	47	14	67	36	66	58	51	.23	−4.5	4	6,785	s.	28	nw.	23	14	11	5	4.0	.0	.0
Dubuque	700	81	96	29.20	29.93	.00	77.4	+8.0	98	20	88	47	14	66	31	66	60	59	1.74	−2.6	7	4,653	sw.	22	nw.	30	14	9	7	4.3	.0	.0
Keokuk	614	64	78	29.31	29.97	+.03	80.0	+7.5	99	6	91	55	14	69	28	67	61	54	6.88	+2.8	7	5,120	sw.	19	sw.	8	19	8	3	3.0	.0	.0
Cairo	358	87	93	29.62	29.99	+.02	79.6	+3.3	98	21	90	54	14	70	27	69	64	63	.91	−2.9	3	4,845	s.	28	ne.	13	18	4	8	3.9	.0	.0
Peoria	609	11	45	29.33	29.98	+.03	78.9	+8.0	101	26	92	46	14	66	34	67	62	60	1.15	−2.6	5	4,006	sw.	15	sw.	8	22	6	2	2.0	.0	.0
Springfield, Ill.	636	5	191	29.31	29.97	+.02	80.7	+8.5	101	30	93	50	14	68	29	68	62	57	3.29	−.8	6	6,907	sw.	31	nw.	28	19	9	2	3.0	.0	.0
Hannibal	534	74	109	29.41	29.97	+.02	79.2	+6.7	100	11	91	49	14	67	33				1.56	−2.3	4	5,874	sw.	24	sw.	29	19	8	3	2.7	.0	.0
St. Louis	568	265	303	29.38	29.98	+.03	81.7	+6.9	102	30	92	56	14	72	27	68	60	51	.15	−3.7	2	7,056	sw.	33	nw.	28	22	7	1	2.2	.0	.0
Missouri Valley							79.7	+8.9										48	2.15	−2.1										3.1		
Columbia, Mo	784	6	84	29.16	29.97	+.02	78.0	+5.2	99	30	90	48	14	66	32				2.18	−2.6	5	4,980	s.	18	n.	12	22	8	0	2.2	.0	.0
Kansas City	963	10	86	28.94	29.93	+.01	81.8	+8.2	102	29	92	54	13	71	27	66	57	46	1.46	−3.5	4	5,610	s.	34	sw.	27	20	6	4	2.6	.0	.0
St. Joseph	967	11	49	28.92	29.92		80.6		102	6	92	49	14	69	32	66	59	52	6.05	+1.1	6	5,576	s.	24	sw.	24	23	4	3	2.4	.0	.0
Springfield, Mo	1,324	98	104	28.62	29.99	+.04	78.2	+5.7	98	23	88	56	13	68	26	66	59	55	3.43	−1.2	3	5,973	s.	29	sw.	27	24	6	0	2.5	.0	.0
Iola	984	11	50	28.94	29.95	+.02	79.7	+5.6	102	23	93	47	14	66	36				.73	−4.7	3		s.				14	11	5			
Topeka	987	92	107				81.8	+8.4	106	29	96	51	14	68	34				2.25	−2.4	6	6,758	s.	38	nw.	27	19	9	2	2.4	.0	.0
Lincoln	1,189	11	81	28.66	29.88	−.02	80.4	+9.0	107	6	93	48	13	68	35	65	56	48	2.53	−1.8	5	7,153	s.	38	w.	29	15	11	4	3.8	.0	.0
Omaha	1,105	115	122	28.76	29.90	−.01	81.5	+9.9	107	6	93	51	13	70	32	65	55	45	.25	−4.3	3	5,347	s.	28	ne.	11	15	12	3	3.6	.0	.0
Valentine	2,598	47	54	27.24	29.88	+.02	77.2	+10.3	102	27	91	51	13	63	41	61	51	46	1.10	−1.8	6	7,282	s.	40	sw.	6	17	13	0	3.2	.0	.0
Sioux City	1,135	94	164	28.69	29.86	−.04	80.0	+10.5	107	10	93	48	13	67	34	65	57	50	1.90	−2.1	5	7,756	s.	37	w.	7	12	10	8	4.7	.0	.0
Huron	1,306	59	74	28.49	29.85	−.03	78.4	+12.2	108	26	93	45	13	63	41	63	52	45	2.04	−1.8	10	7,385	se.	31	nw.	22	20	9	1	3.1	.0	.0
Pierre	1,572	70	75	28.20	29.82	−.05	79.8	+11.3	106	26	94	55	13	66	38	62	51	43	2.32	−.6	10	7,035	se.	37	e.	6	17	13	0	3.3	.0	.0
Yankton	1,233	49	57	28.61	29.88	−.01	79.8	+10.9	105	10	92	49	13	67	38				1.65	−2.1	9	5,984	s.	28	s.	1	14	12	4	3.6	.0	.0

TABLE 1.—*Climatological data for Weather Bureau stations, June 1933*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	*H*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Northern Slope							68.4	+6.9										49	0.99	−1.3										3.4		
Billings	3,140	5					71.4		102	16	89	45	8	54	50				.40		4		nw.				10	12	8		0.0	0.0
Havre	2,505	11	67	27.27	29.85	0.00	68.7	+6.7	104	16	83	38	11	55	43	54	43	47	2.47	−.4	12	6,399	sw.	38	sw.	3	13	12	5	4.2	.0	.0
Helena	4,124	89	113	25.75	29.85	−.03	66.2	+7.0	98	15	80	43	6	52	40	52	41	46	.73	−1.6	5	6,556	sw.	32	sw.	29	8	15	7	5.5	.0	.0
Kalispell	2,973	48	56	26.89	29.89	.00	61.9	+4.2	94	15	75	42	2	49	41	52	44	58	1.37	−.7	10	4,869	nw.	23	sw.	3	8	16	6	5.0	.0	.0
Miles City	2,371	48	55		29.87	+.02	73.6	+7.6	104	17	86	49	8	61	37			50	.78	−1.9	8	4,572	ne.	34	w.	20	17	13	0		.0	.0
Rapid City	3,259	50	58	26.55	29.87	+.02	72.6	+8.4	97	25	86	48	8	60	35	60	51	49	1.14	−2.2	6	5,538	w.	35	w.	23	14	14	2	4.0	.0	.0
Cheyenne	6,088	84	101	24.06	29.88	+.04	66.6	+6.2	89	27	80	42	8	54	34	52	40	44	1.03	−.6	7	6,887	s.	30	s.	5	5	22	3	5.3	.0	.0
Lander	5,372	60	68	24.64	29.84	−.01	68.6	+8.1	92	27	84	45	29	53	42	51	37	38	.02	−1.1	1	4,606	sw.	26	sw.	28	17	12	1	3.4	.9	.0
Sheridan	3,790	10	47	26.05	29.86		68.5		94	16	84	44	8	53	40	57	49	54	.07	−2.0	3	3,944	nw.	24	nw.	20	14	15	1	3.9	.0	.0
Yellowstone Park	6,241	11	48	23.92	29.90	+.04	60.0	+4.0	85	15	75	35	6	45	39	47	36	49	1.05	−.9	6	6,352	sw.	30	sw.	9	8	14	8	5.2	.0	.0
North Platte	2,821	11	51	27.02	29.87	+.01	77.0	+9.5	102	30	91	52	13	63	37	62	55	55	1.27	−2.0	6	5,582	s.	36	w.	7	12	13	5	4.3	.0	.0
Middle Slope							78.7	+6.9										42	1.06	−2.0										3.8		
Denver	5,292	106	113	24.76	29.88	+.04	72.8	+6.5	96	28	85	53	8	60	33	54	39	37	.16	−1.2	4	5,667	s.	30	se.	6	9	18	3	4.9	.0	.0
Pueblo	4,685	80	86	25.30	29.87	+.04	73.4	+4.4	98	30	88	50	8	59	40	55	42	42	2.66	+1.3	8	5,116	nw.	38	nw.	7	12	13	5	4.4	.0	.0
Concordia	1,392	50	58	28.48	29.91	+.01	82.0	+9.0	107	30	95	53	13	69	37	65	55	44	1.34	−3.1	8	6,388	s.	24	n.	12	13	12	5	4.0	.0	.0
Dodge City	2,509	10	86	27.37	29.90	+.03	79.9	+7.4	107	30	94	52	14	66	39	61	49	40	1.23	−2.1	7	9,347	s.	35	s.	29	17	10	3	3.1	.0	.0
Wichita	1,358	85	93	28.52	29.90	−.01	82.6	+8.2	109	5	96	55	14	70	39	64	52	41	.83	−3.6	5	8,851	s.	43	w.	29	15	10	5	3.7	.0	.0
Oklahoma City	1,214	10	47	28.69	29.94	+.03	81.7	+5.7	104	25	94	54	14	70	29	75	57	50	.15	−3.5	1	7,251	s.	24	s.	7	16	13	1	3.0	.0	.0
Southern Slope							79.8	+1.8										47	0.57	−2.0										3.4		
Abilene	1,738	10	52	28.17	29.93	+.05	80.9	+1.7	101	25	93	56	14	69	31	65	57	50	.32	−2.7	2	7,514	s.	25	s.	7	17	10	3	3.5	.0	.0
Amarillo	3,676	10	49	26.27	29.90	+.05	79.2	+6.4	104	29	93	56	15	65	36	59	47	39	.05	−2.8	1	7,650	s.	34	e.	12	18	12	0	3.1	.0	.0
Big Spring	2,537	5	62	27.36	29.91		81.1		103	4	94	60	16	68	33	65	56	48	.01		1		s.				18	11	1	3.2	.0	.0
Del Rio	944	64	71	28.93	29.89	+.04	81.6	+1.8	99	29	92	61	16	71	27	69	61	57	1.28	−1.3	5	7,539	se.	22	se.	7	13	12	5	4.5	.0	.0
Roswell	3,566	75	85	26.36	29.88	+.08	77.4	+1.1	104	29	92	52	8	63	40	60	47	43	.63	−1.0	5	5,617	se.	29	se.	6	19	9	2	2.7	.0	.0
Southern Plateau							75.2	+1.0										37	0.94	+0.6										3.3		
El Paso	3,778	152	175	26.16	29.83	+0.8	80.0	+.4	102	5	93	59	8	67	37	60	44	38	2.14	+1.6	8	5,906	e.	34	sw.	19	17	9	4	3.3	.0	.0
Albuquerque	4,972	51	66	25.07	29.82		72.2		97	11	87	44	8	58	44	55	40	41	3.81		12	6,315	se.	42	s.	19	12	13	5	4.5	.0	.0
Santa Fe	7,013	38	53	23.35	29.87	+.06	66.1	+1.3	88	11	78	42	7	54	33	51	38	44	2.30	+1.2	12	4,267	e.	19	s.	6	10	6	14	5.7	.0	.0
Flagstaff	6,907	10	59	23.41	29.84	+.06	60.6	+1.3	88	11	78	30	1	43	47	45		41	1.04		5	6,840	sw.	30	sw.	4	10	18	2		.0	.0
Phoenix	1,108	10	107	28.65	29.77	+.03	87.6	+3.1	112	11	103	60	6	73	43	61	40	23	.23	+.2	3	4,777	e.	24	n.	14	21	5	4	2.3	.0	.0
Yuma	141	9	54	29.62	29.77	+.03	85.2	+.5	114	11	102	58	7	68	49	64	49	36	T	.0	0	3,944	sw.	21	e.	15	29	1	0	.8	.0	.0
Independence	3,957	5	26	25.91	29.87	+.09	71.8	−.5	100	13	89	44	2	55	42	50			.05	.0	2		s.				24	4	2			
Middle Plateau							70.2	+5.0										29	0.06	−0.5										2.7		
Reno	4,532	74	81	25.43	29.85	−.01	65.2	+4.2	98	13	81	42	19	49	43	48	33	39	.01	−.3	1	6,386	w.	28	sw.	8	20	6	4	2.8	.0	.0
Tonopah	6,090	12	20				67.8		90	13	80	39	6	56	28	48	30	30	.18		1		se.									
Winnemucca	4,344	18	56	25.56	29.86	−.02	68.0	+5.2	100	14	85	42	30	50	49	48	30	41	.02	−.7	2	5,695	sw.	26	sw.	27	19	9	2	2.6	.0	.0
Modena	5,473	10	46	24.60	29.83	+.01	64.8	+1.5	93	12	83	36	6	46	47	45	23	24	T	−.3	0	8,524	sw.	31	sw.	27	21	5	4	2.5	.0	.0
Salt Lake City	4,360	86	210	25.54	29.80	−.05	75.6	+8.2	95	21	88	53	4	63	35	54	36	27	T	−.8	0	6,119	se.	30	se.	27	23	3	4	2.7	.0	.0
Grand Junction	4,602	60	68	25.34	29.84	+.01	77.2	+5.8	97	27	91	54	7	63	38	53	33	25	.25	−.2	1	6,166	se.	29	s.	5	18	9	3	3.1	.0	.0
Northern Plateau							67.0	+2.9										46	0.58	−0.5										4.7		
Baker	3,471	48	53	26.42	29.96	+.01	61.8	+3.2	96	15	75	41	6	48	39	51	43	57	1.26	−.1	10	4,609	n.	35	sw.	27	12	11	7	4.8	.0	.0
Boise	2,739	79	87	27.07	29.87	−.04	69.7	+4.4	101	15	84	44	6	55	37	54	40	42	.14	−.8	4	4,282	nw.	18	se.	15	11	10	9	4.7	.0	.0
Lewiston	757	40	48	29.12	29.92	−.02	69.1	+2.5	105	14	82	48	2	56	42				.55	−.9	5	3,190	e.	24	w.	6	11	8	11	5.6	.0	.0
Pocatello	4,477	60	68	25.43	29.84	−.03	69.3	+7.1	94	13	84	47	2	55	38	51	34	34	.15	−.9	4	6,071	se.	34	sw.	27	16	8	6	3.5	.0	.0
Spokane	1,929	101	110	27.90	29.92	−.02	64.0	+1.2	97	14	77	40	10	51	42	52	42	51	1.16	−.1	7	5,111	sw.	20	sw.	4	9	11	10	5.2	.0	.0
Walla Walla	991	57	65	28.87	29.93	−.03	68.0	+1.5	100	14	80	45	1	56	38	54	44	46	.42	−.7	6	4,391	s.	18	w.	21	14	8	8	4.5	.0	.0
Yakima	1,076	58	67	28.80	29.94		67.0	+.6	100	13	80	41	10	54	39	53	40	43	.41	−.2	3	5,276	nw.	23	sw.	7	12	12	6	4.4	.0	.0
North Pacific Coast Region							58.5	+0.1										70	1.35	−0.2										6.0		
North Head	211	11	56	29.84	30.07	+.08	54.5	−.3	62	19	58	45	1	51	12	51	49	82	2.08	−.2	12	9,192	n.	49	s.	7	7	10	13	6.4	.0	.0
Port Angeles	29	8	53		30.07		54.2		79	12	62	37	1	47	31				.73	−.2	5	6,369	sw.	24	w.	25	5	12	13		.0	.0
Seattle	125	90	321	29.90	30.02	+.02	60.2	+1.2	82	12	68	46	9	52	32	52	45	61	1.26	−.1	9	5,952	n.	26	sw.	7	8	10	12	6.0	.0	.0
Tacoma	194	172	201	29.84	30.05	+.02	58.9	+.2	80	12	67	44	1	50	28				1.21	−.2	6	6,250	n.	26	sw.	8	9	13	8	5.6	.0	.0
Tatoosh Island	86	10	54	29.97	30.07	+.05	52.6	−.4	64	12	56	43	8	49	14	50	47	86	2.04	−1.2	11	6,025	sw.	23	ne.	11	3	15	12	6.8	.0	.0
Medford	1,329	29	58	28.57	29.96		64.4		97	13	78	40	1	50	45	54	47	60	.15	−.6	3	5,295	nw.	30	nw.	1	12	10	8	5.0	.0	.0
Portland, Oreg	153	68	106	29.87	30.03	−.01	62.3	−.1	91	12	71	45	10	53	33	54	48	65	2.60	+1.1	8	4,449	nw.	22	sw.	8	5	9	16	6.5	.0	.0
Roseburg	510	75	99	29.48	30.03	.00	62.4	−.1	87	13	74	44	20	51	37	54	48	64	.72	−.4	3	3,902	n.	16	nw.	27	6	13	11	5.8	.0	.0
Middle Pacific Coast Region							63.9	−0.5										65	0.13	−0.2										3.3		
Eureka	62	73	89	30.02	30.09	+.04	55.6	+1.3	67	24	60	46	19	52	14	53	52	90	.30	−.4	3	5,784	n.	30	sw.	1	7	16	7	5.7	.0	.0
Red Bluff	330	5	58	29.54	29.89	+.01	75.7	+.9	110	13	90	49	2	61	39	58	44	39	.26	−.2	1	4,916	se.	18	se.	15	21	6	3	2.3	.0	.0
Sacramento	69	106	117	29.84	29.91	+.02	68.6	−.8	101	13	83	45	2	54	42	56	47	53	.08	−.1	1	6,715	s.	21	sw.	27	24	6	0	1.7	.0	.0
San Francisco	155	208	243	29.81	29.96	+.02	57.6	−.9	73	13	64	49	2	51	22	52	49	79	.01	−.2	1	6,928	w.	26	w.	17	13	8	9	4.1	.0	.0
San Jose	141	12	110	29.85	30.00		62.0	−3.0	88	13	74	44	2	50	39				T	−.1	0	4,930	nw.	21	nw.	27	20	8	2	2.7	.0	.0
South Pacific Coast Region							66.7	−2.0										64	0.21	+0.1										3.6		
Fresno	327	89	98	29.55	29.90	+.05	73.5	−2.3	108	14	88	48	3	58	36	57	43	41	.07	.0	1	6,665	nw.	22	nw.	15	23	4	3	2.0	.0	.0
Los Angeles	338	159	191	29.59	29.95	+.05	65.0	−1.4	85	13	74	52	3	56	28	57	54	73	.47	+.4	2	3,940	sw.	14	w.	20	16	11	3	4.4	.0	.0
San Diego	87	62	70	29.85	29.94	+.02	61.6	−2.3	70	19	66	53	1	57	15	57	54	79	.08	.0	1	4,847	sw.	20	nw.	18	5	23	2	5.4	.0	.0
West Indies																																
San Juan, P.R.	82	9	54	29.88	29.97		80.6	+.9	91	3	86	74	29	76	16				7.97	+2.7	17	7,695	e.	26	ne.	7	1	22	7	6.2	.0	.0
Panama Canal																																
Balboa Heights	118	6	97		[1] 29.84	+.02	79.6	−.5	90	22	85	72	10	74	16			[1] 87	14.36	+6.2	23	3,308	nw.	18	s.	1	0	10	20	7.9	.0	.0
Cristobal	36	6	97		[1] 29.84	+.01	81.6	+1.4	90	16	88	73	27	76	16	76	75	[1] 83	15.88	+2.1	25	3,770	se.	21	n.	25	0	6	24	8.5	.0	.0
Alaska																																
Fairbanks	454	68	87		[2] 29.85		53.7		87	22	65	32	1	42	39			58	1.52	+.1	10	4,255	n.	22	ne.	1	5	11	14		.0	.0
Juneau	80	11	50	[2] 29.85	[2] 29.94		51.4		77	24	58	37	4	45	26	47	43	77	6.92		19	4,824	s.	25	e.	1	5	7	18	7.7	.0	.0
Hawaiian Islands																																
Honolulu	38	86	100	[2] 30.03	[2] 30.07		74.8	−1.8	81	13	79	68	11	71	11	67	64	69	.57	−.4	12	7,820	e.	30	ne.	29	4	16	10	6.0	.0	.0

[1] Pressure not reduced to mean of 24 hours.

[2] Observations taken hourly.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, June 1933*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*In.*	*In.*	*In.*
Cape Race, N.F	99						39.2		31		3.11		0.0
Sydney, C.B.I	48	29.82	29.87	−0.08	57.0	+1.6	68.9	45.1	85	35	4.36	+1.13	.0
Halifax, N.S	88	29.77	29.87	−.08	59.4	+1.7	70.0	48.8	84	36	3.34	−.42	.0
Yarmouth, N.S	65	29.77	29.84	−.11	56.9	+1.9	65.2	48.6	80	38	2.03	−.90	.0
Charlottetown, P.E.I	38	29.78	29.82	−.10	57.6	+.2	66.1	49.1	83	38	2.38	−.29	.0
Chatham, N.B	28	29.72	29.75	−.14	60.4	+.4	72.0	48.9	87	35	6.75	+3.29	.0
Father Point, Que	20												
Quebec, Que	296	29.54	29.85	−.07	64.2	+3.0	74.6	53.9	92	38	5.95	+2.30	.0
Doucet, Que	1,236												
Montreal, Que	187	29.65	29.85	−.09	68.7	+3.8	77.7	59.7	94	45	1.70	−1.83	.0
Ottawa, Ont	236	29.63	29.89	−.05	68.2	+2.9	80.3	56.1	97	40	1.69	−1.23	.0
Kingston, Ont	285	29.61	29.91	−.06	65.8	+2.4	74.2	57.4	88	40	1.92	−.51	.0
Toronto, Ont	379	29.53	29.92	−.05	67.5	+4.1	78.2	56.8	92	43	1.84	−.96	.0
Cochrane, Ont	930												
White River, Ont	1,244												
London, Ont	808				67.0		79.7	54.3	94	34	4.47		.0
Southampton, Ont	656												
Parry Sound, Ont	688												
Port Arthur, Ont	644	29.23	29.94	.00	61.8	+5.4	71.2	52.4	87	38	1.99	−.74	.0
Winnipeg, Man	760	29.04	29.85	−.04	67.9	+5.7	79.7	56.2	97	35	.07	−3.22	.0
Minnedosa, Man	1,690												
Le Pas, Man	860												
Qu'Appelle, Sask	2,115	27.61	29.81	−.06	63.8	+3.9	75.7	51.8	98	31	2.63	−.79	.0
Moose Jaw, Sask	1,759												
Swift Current, Sask	2,392	27.32	29.79	−.08	62.5	+2.5	72.8	52.1	103	31	2.86	+.19	.0
Medicine Hat, Alb	2,365	27.34	29.77	−.08	66.6	+4.6	80.1	53.1	104	38	2.08	−.68	.0
Calgary, Alb	3,540	26.20	29.80	−.04	59.1	+3.1	72.7	45.5	92	35	1.12	−1.33	.0
Banff, Alb	4,521												
Prince Albert, Sask	1,450	28.32	29.87	.00	61.8	+4.1	72.8	50.9	92	36	2.21	−.30	.0
Battleford, Sask	1,592	28.11	29.82	−.04	62.3	+2.8	75.8	48.7	100	34	2.07	−1.24	.0
Edmonton, Alb	2,150												
Kamloops, B.C	1,262												
Victoria, B.C	230	29.77	30.02	+.01	55.7	−.6	63.4	48.0	80	41	1.15	−.05	.0
Barkerville, B.C	4,180												
Estevan Point, B.C	20												
Prince Ruppert, B.C	170												
Hamilton, Ber	151												

SEVERE LOCAL STORMS, JUNE 1933

[Compiled by Mary O. Souder]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Mandarin, Fla	1	1:30–2 p.m.	[1] 2		$7,500	Heavy hail	Crops damaged; amount of loss to citrus fruits not estimated; chickens killed and roofs damaged.	Official, U.S. Weather Bureau.
Switzerland, Fla	1	2:30 p.m.				do	Stones as large as hen's eggs; severe damage to crops; some areas complete loss; roofs damaged.	Do.
Titusville, Fla	1	2:50–3 p.m.	[1] 1		500	do	Stones as large as hen's eggs; crops damaged	Do.
New Smyrna, Fla	1	3:30 p.m.	[1] 2			do	Considerable damage to young citrus trees; many windows broken; automobile tops damaged.	Do.
Bushnell, Fla	1	3:45–4 p.m.				Hail	Pepper and tomato crops damaged considerably.	Do.
Baldwin, Fla	1	5 p.m.	[1] 4			Heavy hail	Small crop damage; property loss not estimated.	Do.
Loretta, Fla	1					do	Stones as large as hen's eggs; hundreds of dollars damage to crops and trees; poultry killed; path several miles wide.	Do.
Barron, Dunn, Chippewa, and Taylor Counties, Wis.	3	11–12 p.m.			20,000	Wind	Barns, silos, and small buildings wrecked	Do.
Clear Lake, S.Dak	3	6 p.m.	[1] 2			Hail and wind	Damage to small buildings; chickens and pigs killed.	Do.
Corona, Wilmot, and Milbank eastward to Big Stone Lake, S. Dak.	3	do	[1] 15	1	100,000	Tornadic wind and hail.	Many buildings destroyed; livestock killed	Do.
Hobbs, N.Mex	4	2:30 a.m.				Tornado	Telephone wires torn down; 1 man injured and 5 buildings wrecked.	Do.
Chicago, Ill	4	8:13 p.m.		1		Thundersquall	Wires blown down; 15 persons injured; basements and streets flooded; trees damaged.	Do.
Port Byron, Rochelle, and Sycamore, Ill., and vicinity.	4				38,000	do	Property damaged	Do.
Manitowoc (near), Wis	4					Rain and hail	Loss from washing and flooding of crops	Do.
North of Marquette to vicinity of Kingston, Wis.	5	5:15 p.m.	150	1	105,000	Tornado	3 persons injured; 50 cattle killed or injured; 4 farm homes wrecked; path 10 miles long.	Do.
Martins Ferry, Ohio, vicinity of.	5	P.m.	2,640		87,500	Hail	Street lighting system out of commission; roofs shattered; trees and shrubbery ruined.	Do.
Wheeling, W.Va	5	P.m.			5,000	Electrical and heavy hail.	Much damage to orchards and truck	Do.
Lena and Oconto Falls, Wis.	5				10,000	Heavy hail	Property damage	Do
Williamsport and Lock Haven, Pa., and vicinity.	5–6	P.m.			7,500	Electrical	Much minor damage by flooding rains; 4 valuable cows killed.	Do.
Loudoun County, Va	6	6–7 p.m.	[1] 2		10,000	Hail	Damage mostly to apple crop; trees broken down and wheat fields cut.	Do.
Worthington, Minn	6	P.m.				Wind and rain	Wires blown down, entire town in darkness; roofs blown off; estimated loss several thousand dollars.	Do.

[1] Miles instead of yards.

Severe local storms, June 1933—Continued

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Wheeler, Iowa	6				835	Wind	Buildings damaged and livestock killed	Official, U.S. Weather Bureau.
Paw Paw and Marcellus, Mich.	6					Wind and hail	Thousands of dollars loss to property, fruit and grain; small buildings blown down.	Do.
Pierce and Dunn Counties, Wis.	6–7	11:30 p.m.–2 a.m.			30,000	Wind	Many barns and other buildings wrecked	Do.
Buffalo and Erie, Niagara, Orleans and Genesee Counties, N. Y.	7	11:35 a.m.–12:05 p.m.		3	1,000,000	Thundersquall	At least 12 persons injured; large damage to electric and telephone lines; many trees uprooted; storm was extensive in farming communities as well as in cities and towns.	Do.
Ludington, Mich., and vicinity.	7	6:53 – 6:57 a.m.				Rain and hail	Hailstones as large as baseballs; several persons injured; damage to fruit and property; a number of birds injured or killed; damage estimated at several thousands.	Do.
Scranton, Pa	7	3 p.m			25,000	Electrical and wind.	Trolley service interrupted; many large trees uprooted; several houses damaged by wind.	Do.
Imperial, Nebr	7	3–4 p.m	[1] 10		5,000	Hail	Property destroyed	Do.
Madison, Nebr	7	4:30 p.m	[1] 4		70,000	Tornado and hail	Property destroyed and crops damaged	Do.
Lyon, Nebr	7	5 p.m	[1] 2		15,000	Wind	Damage to roofs, outbuildings and trees	Do.
Wakefield, Nebr	7	5–6 p.m	[1] 3		5,000	Wind and hail	Property damage	Do.
Buffalo, N.Y	7	5:30 – 8:05 p.m.				Thundersquall	Telephone service disabled; 4 homes struck by lightning; much interference to traffic.	Do.
National Park, N.J	7	6 p.m			15,000	Tornado	2 persons seriously injured; 2 houses carried away; other property damage.	Do.
North Platte, Nebr., eastern portion.	7	6–6:30 p.m.			16,000	Hail and wind	Dwellings, automobiles and trees damaged	Do.
St. Lawrence, S.Dak	7	6:30 p.m				Hail and wind	Crops damaged	Do.
Sioux City, Iowa	7	P.m				Thunderstorm, wind, and hail.	Wires and trees blown down; all traffic tied up; basements flooded.	Do.
Eastern, Pa., and vicinity.	7	do			10,000	Wind, electrical	Many poles and trees blown down; house unroofed.	Do.
Winner, S.Dak	7	do	[1] 1		200,000	Hail and wind	Crops destroyed; some buildings demolished and many damaged.	Do.
Alpena, S.Dak	7					do	Barn and several small buildings destroyed; a cow and many chickens killed.	Do.
Florence and Commonwealth, Wis.	7				600	Thundersquall	Barn wrecked; trees uprooted and windows broken.	Do.
Greenville, Fla	8	1 a.m	880			Wind	Communication lines disrupted; telephone poles and trees blown down.	Do.
Lee County, Va	8	5–10 p.m	[1] 2–3		5,000	Hail	Damage mostly to gardens and fruits; some property loss.	Do.
Harrisburg, Pa	8	P.m				Wind, hail, electrical.	Highest wind ever recorded in June; considerable damage to trees and property.	Do.
Postville, Iowa	8					Heavy hail and wind.	Hundreds of windows broken and roofs damaged; several trees and barns blow down.	Do.
Marinette, Washburn, Jackson, Taylor, and Chippewa Counties, Wis.	8				20,000	Heavy hail	Damage to crops	Do.
Outagamie, Shawano, Oconto, and Marinette Counties, Wis.	8			1	250,000	Wind	1 woman fatally injured; another seriously injured and several minor injuries reported.	Do.
Bethlehem, Pa	8–9	4 p.m			15,000	Wind, electrical	Poles blown down; trees uprooted; 3 buildings unroofed.	Do.
Bland County, Va	9	1–3 p.m	[1] 4–6		5,000	Hail	Damage to grain and fruit; some property damage.	Do.
Elkins and Parsons, W. Va., and vicinity.	9				1,000	do	Damage to roofs and truck gardens	Do.
New York City and northern shore of Long Island.	10	3:30–5:30 a.m.				Thunderstorm	Electric and telephone service disrupted; trees uprooted; many boats blown from their moorings; property loss not estimated.	Do.
Wynot, Nebr., north of	10					Wind and hail	Corn and oats beaten into the ground; gardens stripped; large trees uprooted; small grains total loss; property damaged.	Do.
Hunterdon, Mercer, and Somerset Counties, N.J.	10	A.m				Wind	Wires and trees blown down; a number of houses unroofed.	Do.
Torrington, Wyo	10					Tornado	Trees and small buildings destroyed	Do.
Bethlehem, Pa	10–11	10 p.m			10,000	Wind, electrical	Tree uprooted; much minor damage	Do.
Houghton Lake Village, Mich.	11			4		Gale, hail, electrical.	Telephone connections about the lake were cut off; cottages unroofed; 4 persons drowned.	Do.
Ogemaw and Iosco Counties, Mich.	11				25,000	Electrical and wind.	Considerable damage to buildings; many trees blown down.	Do.
Prentice and Knowlton, Wis.	11				3,500	Wind	3 barns destroyed	Do.
The Bronx, N.Y	12	5 p.m		2		Electrical	5 men standing under a tree struck by lightning, killing 2 instantly.	Do.
Eastern Long Island	12			1		Wind and hail	Farmer crushed by falling tree; much damage to cauliflower, potatoes, and other vegetable crops.	Do.
Hanson, Fla	13	Noon			600	Hail and high wind	Damage to crops; small property loss	Do.
Miami, Fla	14	3:13–6 p.m.				Electrical and heavy rain.	Many parts of the city under water; buildings in business section of down-town area flooded.	Do.
Florence, Lincoln Park, and Brewster, Colo., and vicinity.	14	P.m	[1] 1			Heavy hail	Heaviest hailstorm in the history of the Wet Mountain Valley; much damage to crops, gardens, and fruit trees; estimated damage in thousands.	Do.
Garrett, Harford Howard, and Anne Arundel Counties, Md.	17	4 p.m			210,000	Thunderstorm and hail.	Loss to crops and property	Do.
Rawlins County, Kans	19	4–5 p.m	[1] 4		2,000	Hail and wind	Several small farm buildings demolished; hail drifted 4 feet deep; path 8 miles long.	Do.
Madison (near), Fla	20	6:30 p.m			2,500	Heavy hail and wind.	Timber and fencing blown down; several houses damaged.	Do.
Trinidad (near), Colo	20			1		Electrical	1 person killed by lightning	Do.
Chippewa, Waupaca, Door, and Florence Counties, Wis.	20				35,000	Wind	Property damage	Do.
Torrington, Wyo., and vicinity.	20					Heavy hail	Crops badly damaged; windows and street lights broken; car tops punctured.	Do.
Wilmington, N.C	21	3:30 p.m			1,500	Tornadic winds	Roofs damaged; derrick on a floating pile driver wrecked; two workmen slightly injured; another blown into river; no lightning or thunder during this storm.	Do.
Clayton, N.Y., and vicinity.	21	P.m				Wind, rain, electrical.	Wires and poles down; roofs blown off; tree uprooted and gardens damaged.	Do.

[1] Miles instead of yards

Severe local storms, June 1933—Continued

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Milford, Mich., vicinity of.	21					Severe hail and wind.	Much damage to property, crops and trees	Official, U.S. Weather Bureau.
Sharon Springs, N.Y., and vicinity.	21				7,500	Hail	Damage to fruits and other crops	Do.
Winneshiek, Fayette, and Delaware Counties, Iowa.	22	5-10:30 p.m.				Wind, rain, and hail.	Oats totally destroyed in small areas; tree uprooted; small buildings blown over, 90 to 100 acres of corn severely damaged by heavy hail.	Do.
Woodlawn, Tex	22					Tornado	Workshop and several outbuildings destroyed	Do.
Green River, Wyo., vicinity of.	22					do	Small buildings destroyed; roof lifted from grandstand in the ball park.	Do.
Arkadelphia, Ark., and vicinity.	23				2,000	Wind	Damage to barns, houses, and timber	Do.
Cedar Rapids, Iowa	23					Electrical	200 telephones out of order; slight damage from lightning.	Do.
Raynesford-Brooks, Mont.	23		[1] 1–5		50,000	Hail	10,000 acres of wheat damaged; severe damage to gardens, hay, poultry, and windows.	Do.
America and Marion, Iowa.	24	Noon	2,200			do	Small grains and corn damaged considerably; poultry killed; path 7 miles long.	Do.
Waterloo, Iowa	24	2 p.m.				Electrical and rain.	3 small fires ignited by lightning; sewer washed out; signs blown down.	Do.
Dallas and Winneshiek Counties, Iowa.	24	9:15 p.m.			2,500	Tornado, electrical	Trees blown down; barn destroyed and house damaged.	Do.
Buchanan County, Iowa	24	P.m.				Wind	Poles blown down between Independence and Spencers Grove.	Do.
Waukee, Iowa	24	P.m.				Tornado	House and outbuildings on a farm totally destroyed.	Do.
Hope, Ark	24					Wind	Considerable damage to buildings	Do.
Mena (near), Ark	25	3 p.m.			500	Tornado	Property damaged; path narrow	Do.
Lawrence and Barry Counties, Mo.	25					do	Damage to farm buildings, trees, and crops	Do.
Fergus County, Mont	25			2		Severe electrical	Man and boy killed by lightning while riding the same horse.	Do.
Jamestown, Medina, and Fredonia, N.Y.	25				12,000	Heavy thunderstorms.	Much damage by flooding at Jamestown; 2 barns at Medina and 1 at Fredonia burned after being struck by lightning.	Do.
Fairview, Mont	25–26	P.m.	2,640		4,000	Hail	50 percent loss to crops near the center of the path.	Do.
Arkadelphia, Ark	26				4,000	Wind and hail	Damage to buildings and crops	Do.
Greenbrier, Ark	26					Wind	Considerable damage to houses, barns, and timber.	Do.
Jackson County, Kans	27	4 p.m.				Wind	Small buildings blown down; farm house damaged; loss not estimated; path 12 miles long.	Do.
Pottawatomie County, Kans.	27	6–7 p.m.	[1] 2		4,000	Tornadic winds and hail.	Barn demolished, livestock killed; crops damaged; path 15 miles long.	Do.
Chapman, Kans., 9 miles southeast.	27	7:25 p.m.	[1] 4		8,500	Wind and hail	Barn and smaller buildings blown down; path 4 miles long.	Do.
Springfield, Mo., and vicinity.	27	P.m.			2,800	Tornadic winds, electrical.	Telephone lines burned out; lightning caused several small fires; an orchard of 50 apple trees completely destroyed.	Do.
Milbank, S.Dak	27	do			3,000	Tornado	Scores of haystacks carried away; outbuildings wrecked.	Do.
Janesville, Wis	27				1,000	Wind	Portion of a factory roof blown off	Do.
Jefferson and St. Lawrence Counties, N.Y.	28	3 p.m.				Wind, electrical	Telephone and electric wires down; considerable damage to trees; destruction widespread; loss estimated to be in thousands.	Do.
St. Elmo, Ill	28				1,000	Wind	Property damaged	Do.
Hysham, Mont., and vicinity.	28		[1] 6			Hail	30 percent loss of alfalfa seed	Do.
Arcadia-North Loup, Nebr	29	6 p.m.	5		6,000	Hail	Property damaged	Do.
Merrick and Polk Counties, Nebr.	29	7–8 p.m.	[1] 1–4		50,000	do	Stones as large as baseballs killing hogs and chickens; one person injured.	Do.
Republic County, Kans.	29	7 p.m.			2,000	Tornadic winds	Small buildings and 2 large barns blown down	Do.
Vesper to Bernard, Kans., and vicinity.	29	do	880		6,000	Tornado and heavy hail.	Damage to barns and outbuildings; growing crops damaged by hail.	Do.
Edmund, S.C	29	1 p.m.			4,000	Thundersquali	Damage mostly to peach crop; small church wrecked.	Do.
Chicago, Ill	29	P.m.				do	Basements and streets flooded; traffic delayed; considerable damage by lightinng and high wind.	Do.
Wichit a, Kans	29					Wind	Trees blown down; awnings ripped from their frames; 2 houses damaged by falling tree.	Do.
Ashton, S.Dak	30	3 p.m.	[1] 2			Hail	Damage to crops	Do.
Academy, Stickney Mitchell, Colton, and Dell Rapids, S.Dak.	30	4–5 p.m.	[1] 2–15		310,000	Tornadic wind and hail.	Many buildings demolished or damaged: crops destroyed; livestock and chickens killed.	Do.
Cincinnati, Ohio	30	4:47 – 9:40 p.m.				Severe thunderstorm.	Minor damage to trees, wires, and signs; few houses unroofed.	Do.
Hazelton and Jeddo, Pa., and vicinity.	30	5:45 p.m.				Electrical and wind.	Roundhouse swept away by the wind; telegraph poles and wires down; trees uprooted.	Do.
Esbon, Kans., north of	30	6 p.m.	[1] 3		10,000	Hail and wind	Corn crop damaged by hail; path 10 miles long	Do.
Platte Center, Nebr., 5 miles northeast of.	30	7–8 p.m.	[1] 3		2,000	Wind	Damage mostly to barns, outbuildings and windmills.	Do.
Butler and Hancock Counties, Iowa.	30	9–10 p.m.			15,000	do	Loss of crops and livestock; damage to property	Do.
Wisner-West Point, Nebr.	30	9–11 p.m.	[1] 5		15,000	Wind and hail	Property damaged	Do.
Rushville, Ind	30	P.m.			20,000	Wind and rain	All telephone lines down, roofs blown off; 2 churches and the courthouse damaged by falling trees.	Do.
Scandia, Kans., north and west of.	30	do			2,000	Tornado and hail	Corn fields stripped; barn blown down; smaller buildings blown away and trees twisted; several cattle killed.	Do.
Southern Minnesota	30	do			500,000	Wind	Buildings damaged; large loss to trees	Do.
Oil City, Pa	30	do			5,000	do	Portion of small sanatorium blown in and several patients slightly injured.	Do.
Philadelphia, Pa., and suburbs.	30	do		3	10,000	Wind, electrical	2 children killed when coming in contact with high-tension wire blown down; man killed by falling sign; much minor damage.	Do.
Pine Grove Furnace, Pa.	30	do		2		Electrical	2 members Civilian Conservation Corps killed in camp.	Do.
Green, Lafayette, and Rock Counties, Wis.	30				2,500	Heavy hail	No details	Do.
Snowbelt, Mont., 10 miles southwest.	30		[1] 5			Hail	Heavy damage to crops	Do.
Trempealeau and Marquette, Counties, Wis.	30				2,500	Thundersquall	Several barns damaged and small buildings blown down.	Do.

[1] Miles instead of yards.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, June 1933

Chart I. Departure (°F.) of the Mean Temperature from the Normal, June 1933

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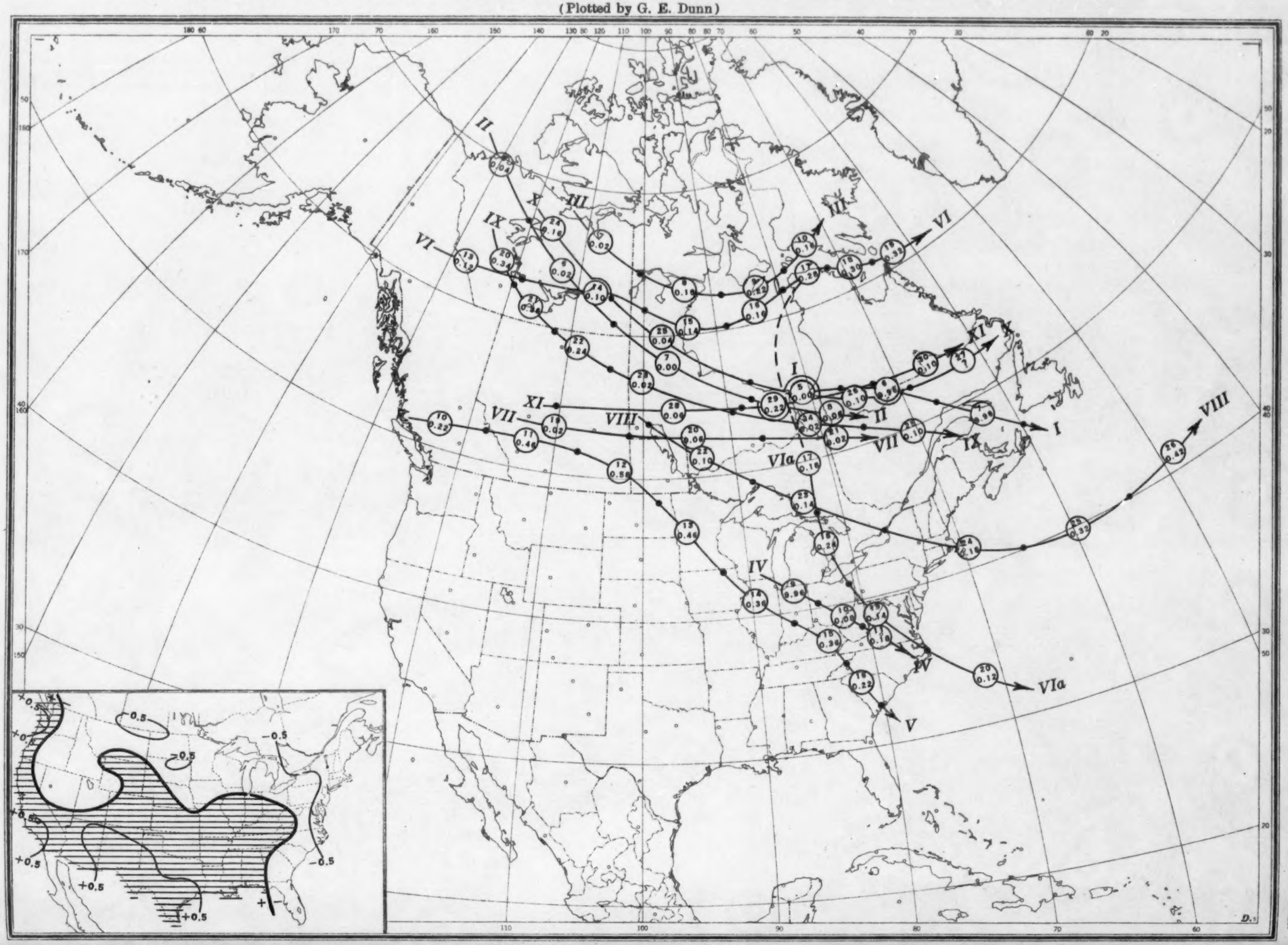
Chart II. Tracks of Centers of Anticyclones, June 1933. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by G. E. Dunn)



Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

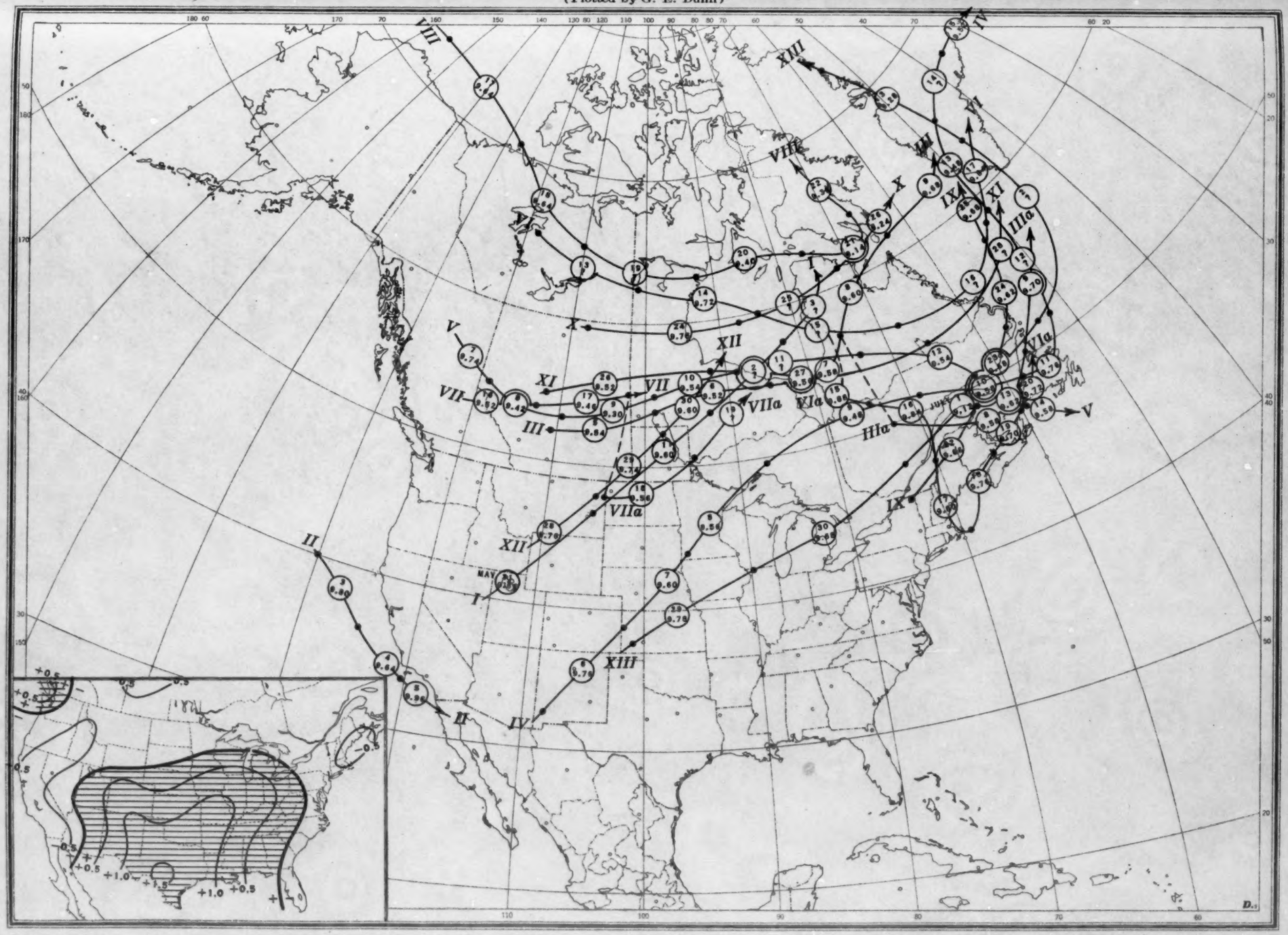
Chart III. Tracks of Centers of Cyclones, June 1933. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by G. E. Dunn)

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, June 1933. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by G. E. Dunn)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

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Chart IV. Percentage of Clear Sky between Sunrise and Sunset, June 1933

Chart V. Total Precipitation, Inches, June 1933. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, June 1933. (Inset) Departure of Precipitation from Normal

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Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, June 1933

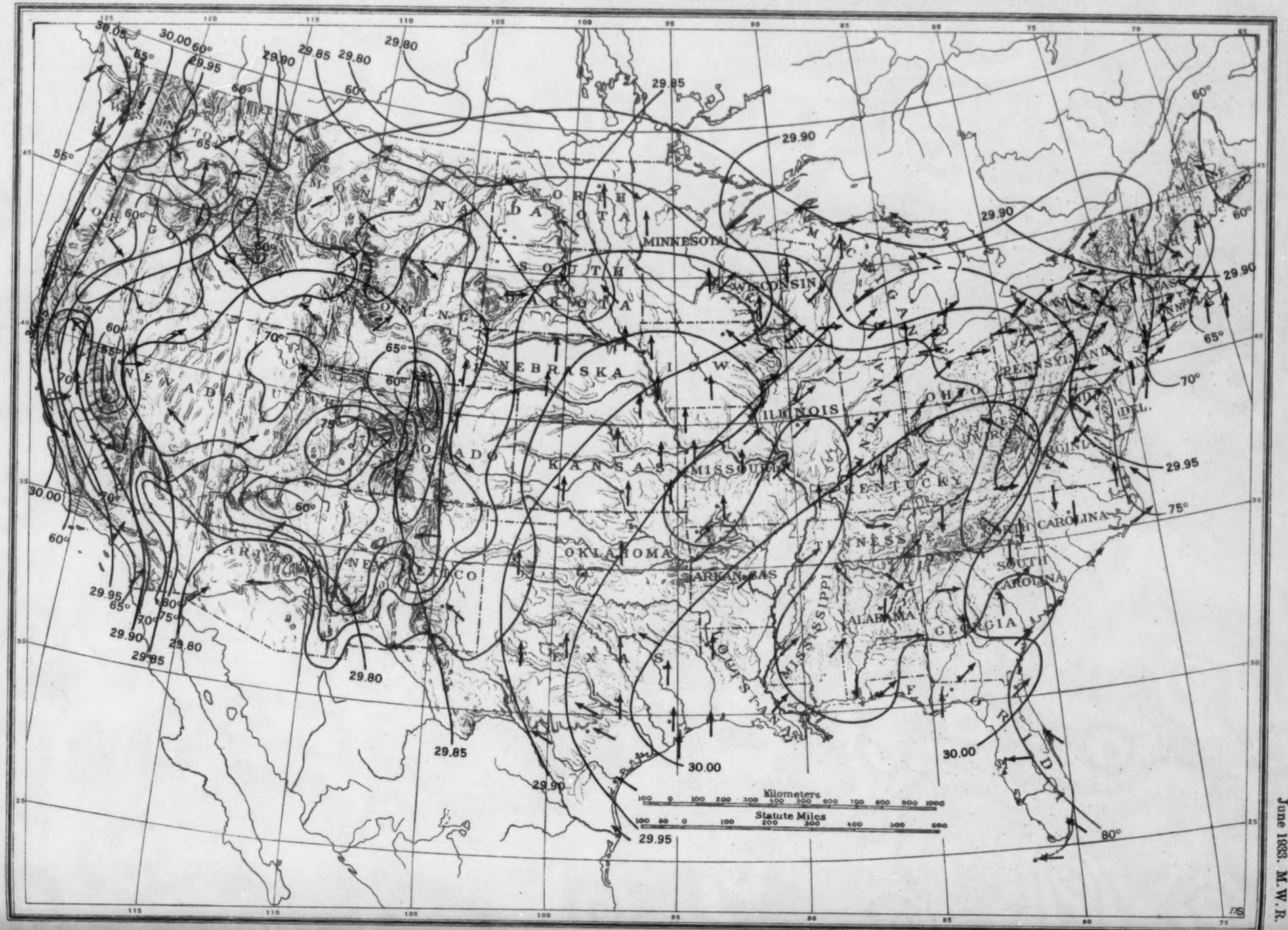


Chart VIII. Weather Map of North Atlantic Ocean, June 3, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)

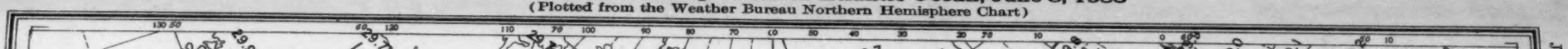
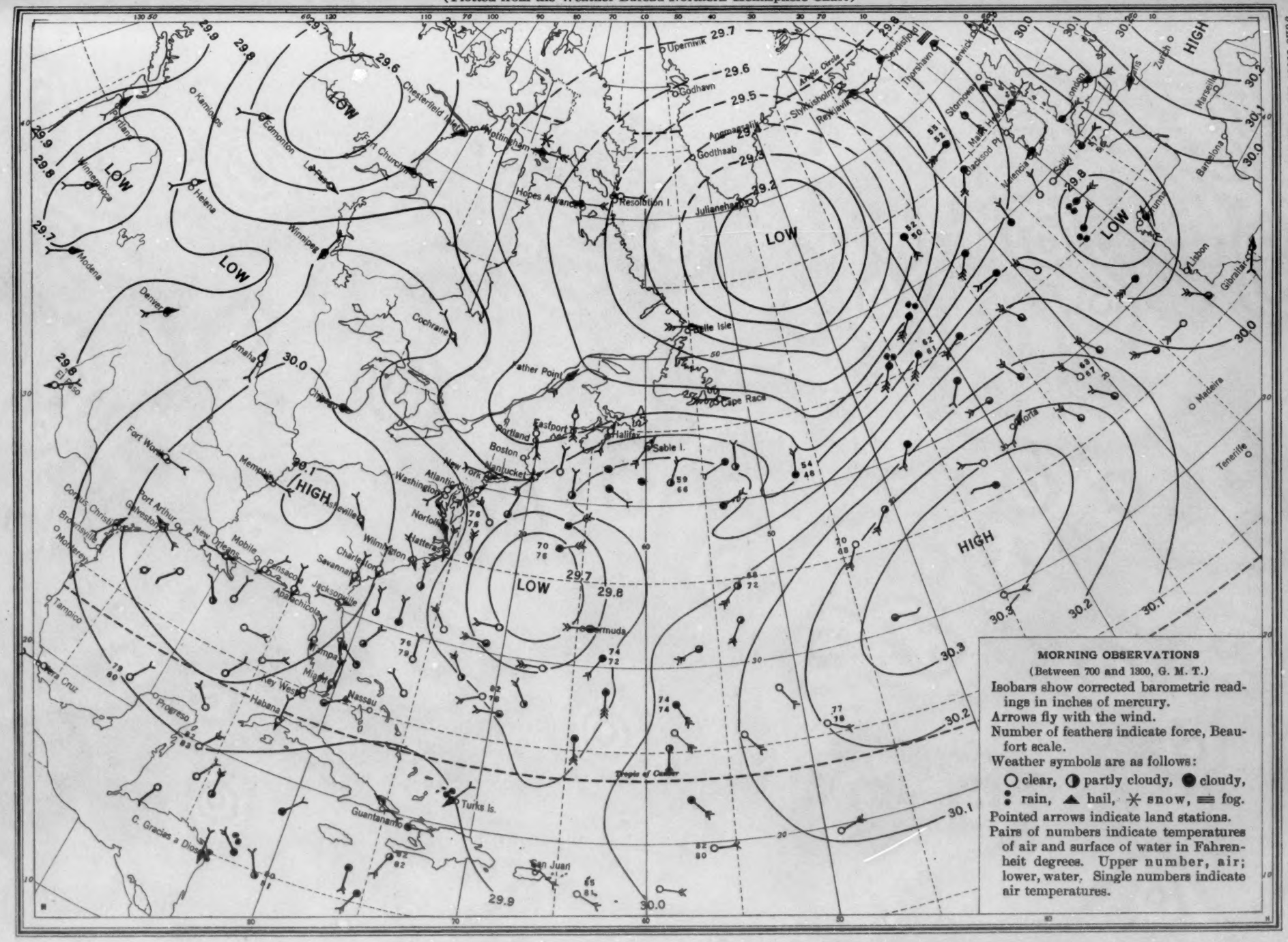


Chart VIII. Weather Map of North Atlantic Ocean, June 3, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicate force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

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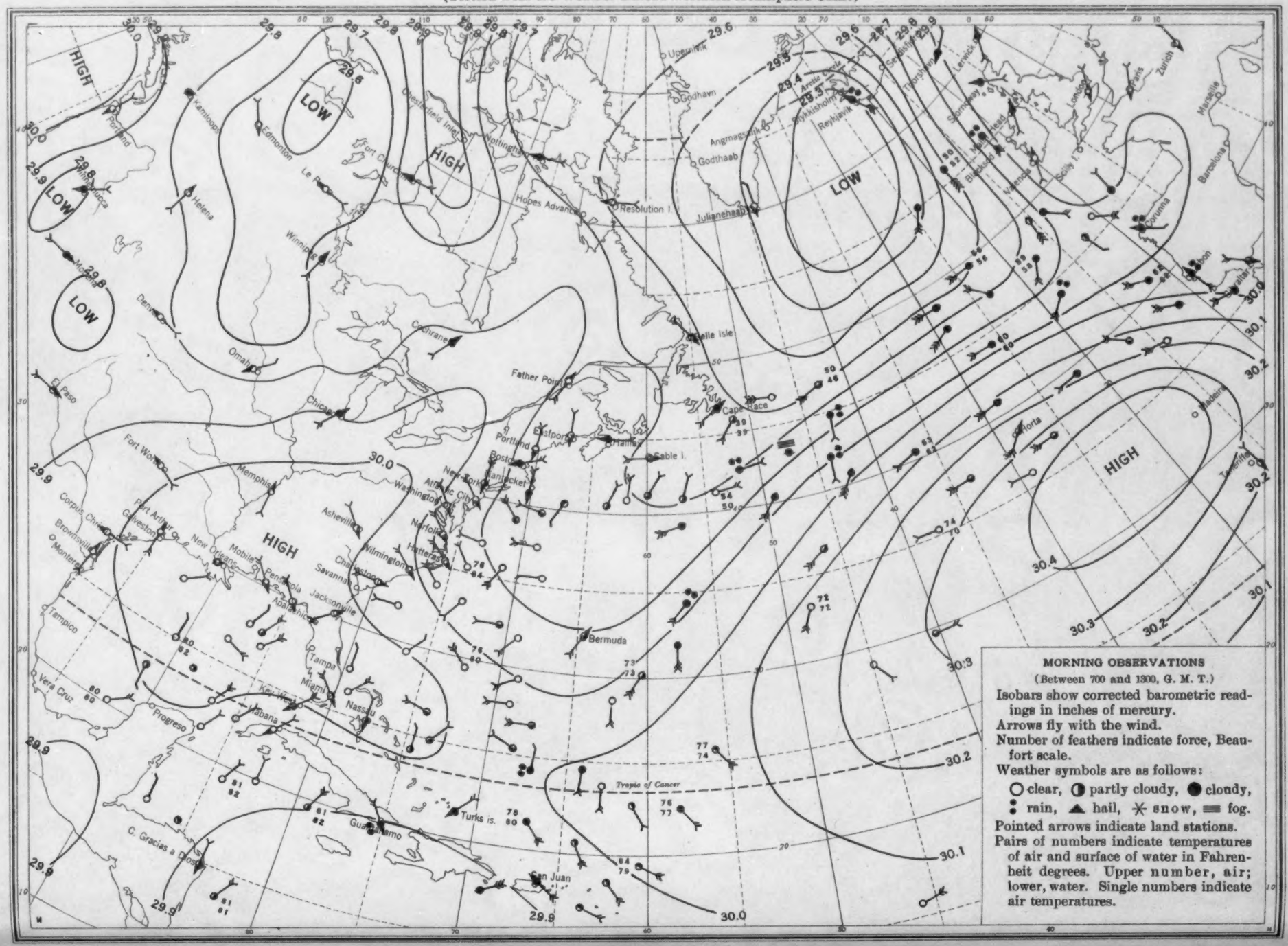
Chart IX. Weather Map of North Atlantic Ocean, June 4, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1900, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicate force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, 〓 fog.

Pointed arrows indicate land stations.

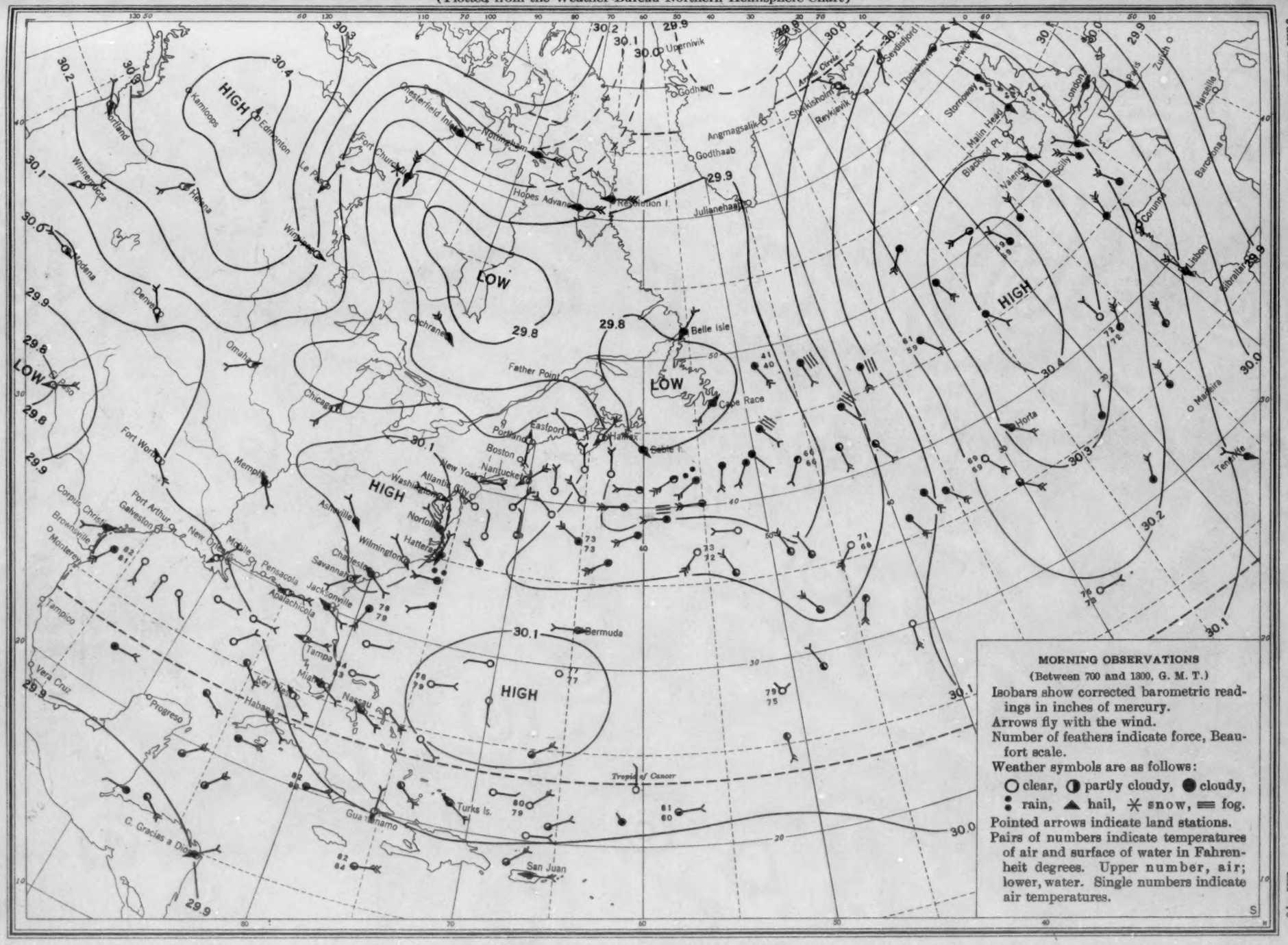
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

Chart X. Weather Map of North Atlantic Ocean, June 11, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart X. Weather Map of North Atlantic Ocean, June 11, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1800, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicate force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⋮ rain, ▲ hail, ✳ snow, ═ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

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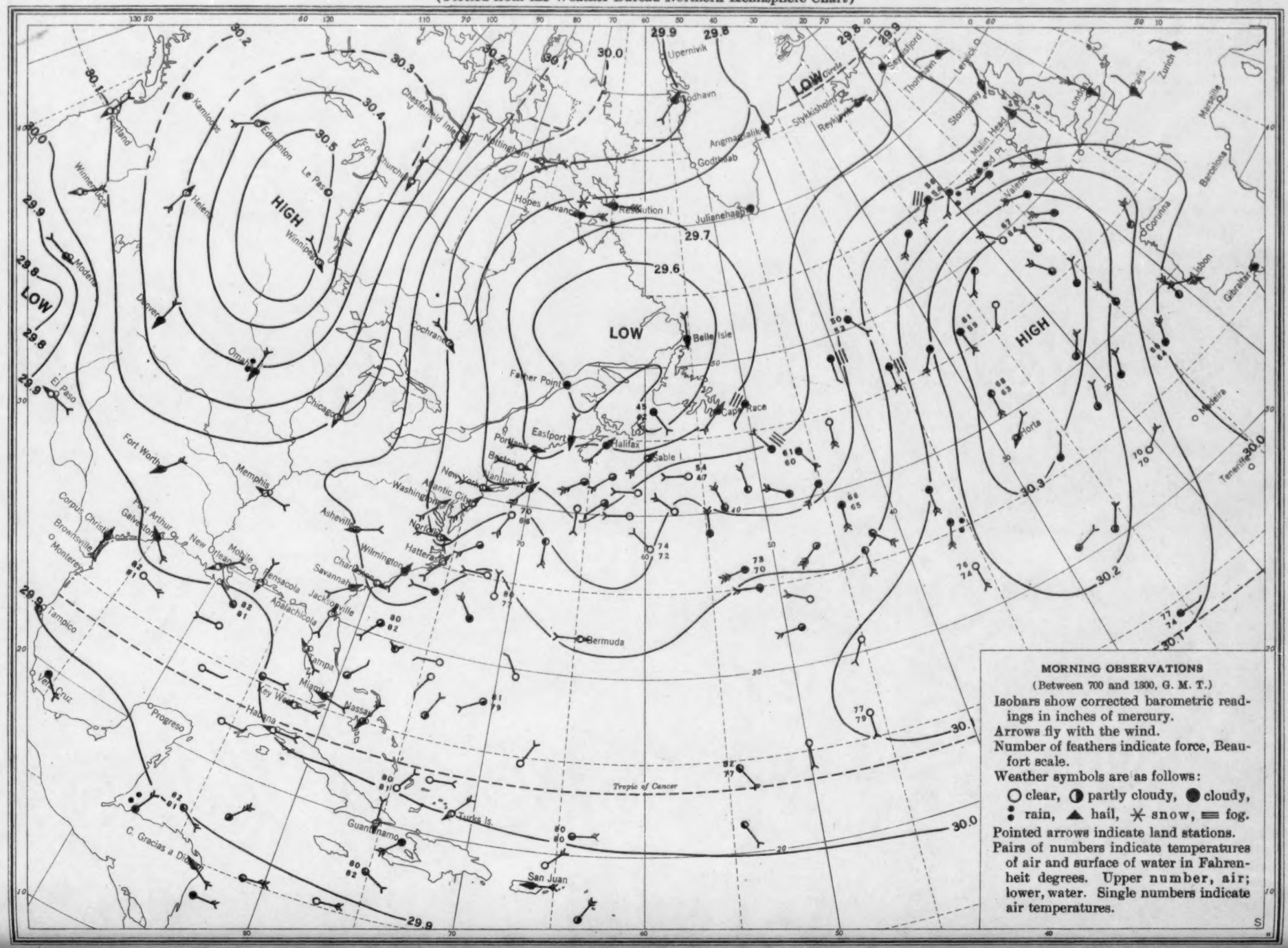
Chart XI. Weather Map of North Atlantic Ocean, June 12, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicate force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, : rain, ▲ hail, ✳ snow, ═ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.